MACHINERY.

April, 1904.

# VARIABLE SPEED MOTORS.—1.

## TYPES MADE BY THE GENERAL ELECTRIC COMPANY.

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Variable speed machines of every kind have always been driven from shafts running at a constant velocity, and all the speed changes required have been obtained by means of mechanical devices that as a rule form part of the machine. In the direct-connected motor-driven tools which are continually growing in favor, the old practice is considerably modified, the speed variations being obtained, in part or in whole, by varying the velocity of the motor. Many persons, not familiar with the operation of motors suppose that they are essentially constant speed machines, but such is not the case. A series wound motor is a variable speed machine, and its velocity will decrease as the load increases. A shunt wound motor will run at a nearly constant speed with any load from zero up to its full rated capacity, provided it is proportioned so as to attain such a result. Compound wound motors will also run at nearly a constant velocity. Alternating current motors of the induction type, which are the only ones suitable for driving machinery, can be proportioned so as to run at nearly a constant velocity with load changes, or they can be proportioned so that the velocity will drop as the load increases. Shunt and compound direct current motors, and induction motors can be provided with controllers by means of which the speed may be varied in any manner desired. In considering the question of speed variation the points of importance to be decided are as to the most economical and desirable method, all things considered, and also as to the extent to which it is advisable to carry the speed variation.

As to the extent of variation in speed that is possible it can be said that it is unlimited, that is, if the normal velocity is, say, 1,000 it can be reduced to one revolution per minute, or it can be increased to a point where all the power of the motor is absorbed in overcoming the resistance to rotation, provided centrifugal force does not throw the armature to pieces before this velocity is reached. It being possible, therefore, to vary the speed to any extent, the question is, how much of a variation is profitable? In many cases it is necessary that the torque remain nearly constant at all speeds, hence the power developed by the motor will vary directly as the velocity. A great many persons who do not give the subject proper thought consider that this is a feature peculiar to motors, and that it is a point against them; but a moment's reflection will show that a steam engine will act in the same manner, that is, if the steam pressure and point of cut-off remain unchanged, the power will vary directly as the speed. In a steam engine the power can be varied by varying the pressure, and in like manner the power of a motor can be varied by varying the voltage of the current that drives it.

If we desire to obtain a speed variation of five to one with constant torque, the power of the motor at the high velocity will be five times as great as at the lowest, from which it follows that at the latter speed the motor is five times as large as it need be if the change in velocity were obtained without reducing the motor speed, in other words, by means of gearing. Changes in speed obtained by means of the motor are gradual and can be effected without stopping the machine, hence they are more desirable than changes obtained by means of gearing, and this advantage offsets the increased size of motor required to effect the speed variation. In deciding to what extent speed variation shall be obtained by means of the motor, the advantages derived therefrom must be weighed against the greater cost due to the increased size of motor.

There are three systems of control commonly used to vary the speed of continuous current motors, the rheostat, the field regulation and the multivoltage systems. The General Electric Company furnishes motors and controllers to operate under all these systems.

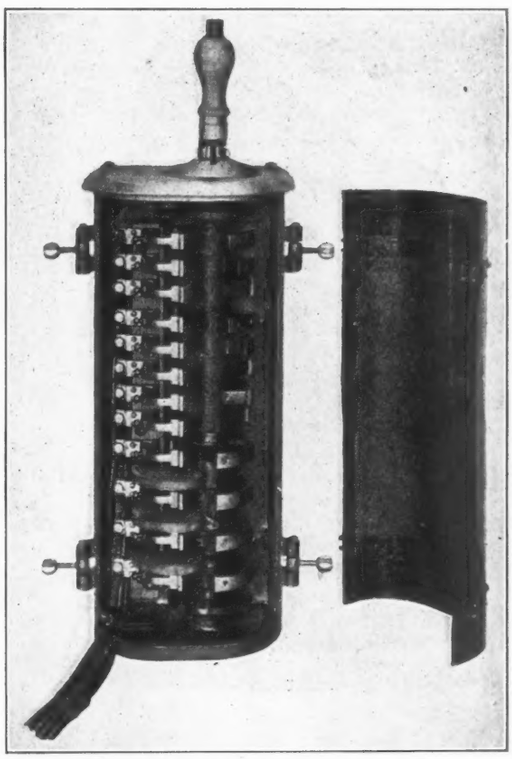


Fig. 1. General Electric Type of Controller for Field Regulation.

The rheostat control is the simplest of all methods of regulation, but is at the same time the most inefficient, owing to the fact that the reduction in velocity is obtained by introducing resistance in the armature circuit, and this resistance absorbs electrical energy at a rate that is substantially equal to the reduction in speed; so that the amount of energy required to run the motor is practically the same at all velocities. There is another objection to the rheostat controlling system that is not generally taken into account, and which, perhaps, is not so well understood as it should be. This objection is that when resistance is introduced in the armature circuit of a shunt or compound wound motor, the self-regulating property is impaired; that is, the motor will no longer run at a substantially uniform velocity with light

and heavy loads. If the resistance introduced in the armature circuit is small, the effect upon the regulation is not very great, but it becomes sufficient to be decidedly serious if the resistance introduced is enough to effect a large reduction in speed. Owing to this interference with the speed regulation, if a motor provided with the rheostatic control is used to operate a tool that does intermittent work, for example a lathe turning off the side of a crank, the speed will drop when the tool is cutting, and will increase as soon as the

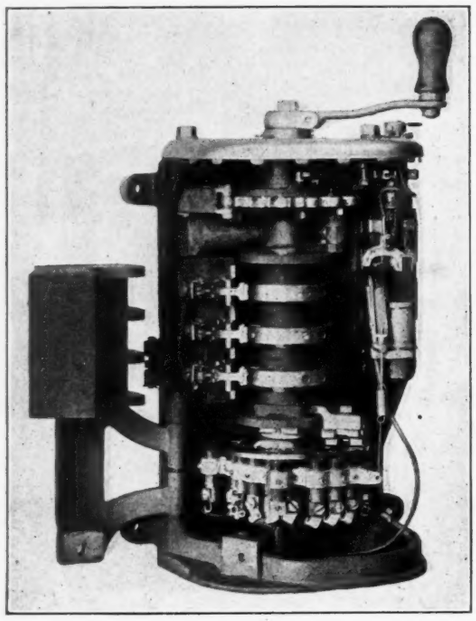


Fig. 2. View of Controller, showing Stationary Contacts and Cylinder Rings.

tool leaves the work. Under these conditions, if the resistance in the armature circuit is large, the motor may speed up so much by the time the tool reaches the work again as to break or grind the point away. If the lathe is used to face off pulleys, or for any other work in which the cut is continuous, the only objection to the rheostat method is its low efficiency, otherwise it is equal to any speed varying system, as it gives any velocity from the normal motor speed down to zero.

The General Electric rheostat controller operates in the manner illustrated in the diagram Fig. 3. The parts marked *H*, *I*, *J*, are contact strips mounted upon the surface of a cylinder, the controller being of a design similar to that commonly used on electric cars. The circles, *F*, *C*, and *T*2 are stationary contacts so located that as the cylinder revolves they slide over the strips, or rings, *H*, *I*, *J*. The circles *D*, *A*, *AA*, *R*10, together with the two rectangles on their right, and the four on their left represent an independent reversing switch, the central vertical row of circles being the stationary contacts, and the rectangles on the sides being the movable contacts, these latter being mounted upon the surface of a small cylinder in a manner similar to the rings, *H*, *I*, *J*.

The true position of the contacts, *F*, *C*, *T*2, when the controller is at the off position, is along the vertical line marked *E*; they are drawn at the extreme left so as not to confuse the diagram. An arm, *G*, is electrically connected with ring *H*, and its lower end is arranged so as to slide over a series of stationary contacts, *R*1 to *R*10, connected with the several sections of the rheostat that is introduced in the circuit of the motor armature. When the motor is running, the stationary contacts, *F*, *C*, *T*2, rest upon the rings, *H*, *I*, *J*, along one of the vertical lines 7, 8, 9, or 10, according to the speed required. In stopping the motor, if it is desired to make a normal stop, the cylinder is rotated until the contacts, *F*, *C*, *T*2, reach the line, *E*. If for any reason a quick stop is desired, the cylinder is rotated a little further, until the contacts, *F*, *C*, *T*2, ride over the two small rectangles marked "Brake," in line with rings, *H*, *I*. This movement carries the lower end of *G* over the stationary contact *B* and thus the circuit of the motor armature is closed through the brake resistance. With this connection the armature acts as a generator and generates a current that flows in the local circuit formed through the brake resistance, and the energy required to generate the current soon absorbs the momentum of the armature. The brake resistance is so proportioned as to bring the armature to a state of rest as rapidly as it can without producing a shock. A no-voltage magnet is provided that acts to open the armature circuit whenever the current fails, and another magnet opens the circuit whenever the current becomes too strong. The last named magnet acts by opening the circuit through the coil of the no-voltage magnet, as is clearly shown in the diagram. A push button is included in the no-voltage magnet coil circuit, so that by pressing this the motor may be stopped at any time without returning the controller handle to the off position. The blow-out coil is for the purpose of breaking the sparks formed when the several switch contacts separate. The wires that carry the full armature current are drawn heavy and those traversed by light currents are drawn fine, thus making the diagram more easily traced out.

In starting the motor, the controller cylinder is rotated until the stationary contacts, *F*, *C*, *T*2, rest upon *H*, *I*, *J*, along the vertical line 1, and this brings the lower end of *G* over the rheostat contact *R*1. If we now trace the circuit from the fuse box at the upper right hand corner we will find that the + wire runs to terminal *F*1 of the motor, which is one end of the series field coils, the motor being compound wound. Passing through the series field the current comes out at *F* and flowing through the wire reaches the blow out coil, then the overload coil and thus to controller contact *F*, which is resting on *J*. As *J* and *I* are connected with each other, and *I* is connected with *D* through wire *a*, the current reaches the latter contact. If the reversing switch is turned to the forward position, the current from *D* will pass through

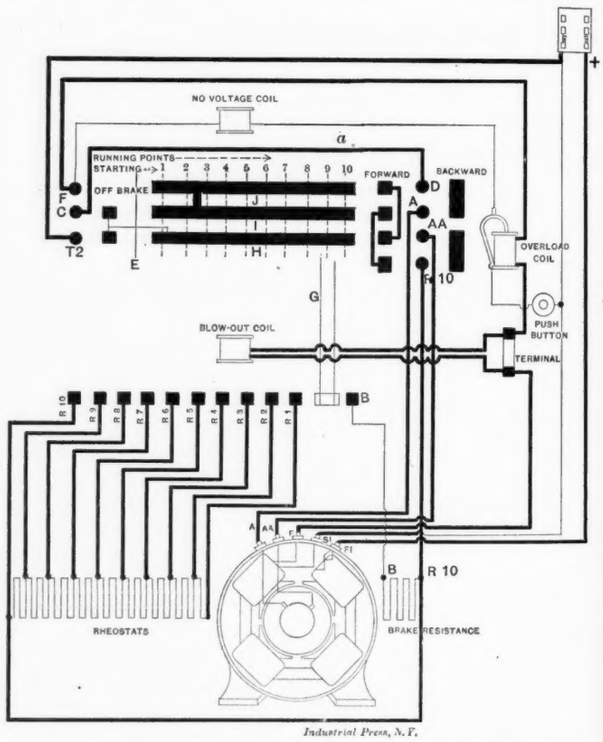



Fig. 3. Diagram of General Electric Type of Rheostat Controller.

the top and third left side contacts to stationary contact *AA* and thus reach the motor armature, passing through the latter to *A* and back to the *A* contact of the reversing switch which is connected with the lower contact *R*10. From this latter contact the current follows the wire *R*10 to the rheostat, and through the latter to contact *R*1, which is connected with *G*. Through *G* the current reaches *H* and thus passes to contact *T*2 and back to the — side of the fuse box. The current for the shunt field of the motor starts from the

motor terminal $F1$ and comes out at $S1$, which, as will be seen, connects directly with the — side of the fuse box.

The diagram of the controller used by the General Electric Company for field regulation is shown in Fig. 4. This controller, like the one just explained, is provided with no voltage and overload magnets. It also has a reversing switch, and brake contacts for effecting a quick stop. In this diagram the stationary contacts $L+$ $C$ $L-$ are drawn in the proper off position, between the brake contacts and rings, $H$, $I$, $J$. The armature rheostat is used simply to keep the current down in starting, but if it were made of sufficient capacity to carry the working current continuously, it could be used for speed regulation. This modification, however, would produce a controller that would be a combination of the rheostat and the field regulating systems.

The path of the currents in this controller is substantially the same as in the rheostat controller, in fact the only difference is that a field rheostat is added, together with a number of contacts, by means of which its several sections may be

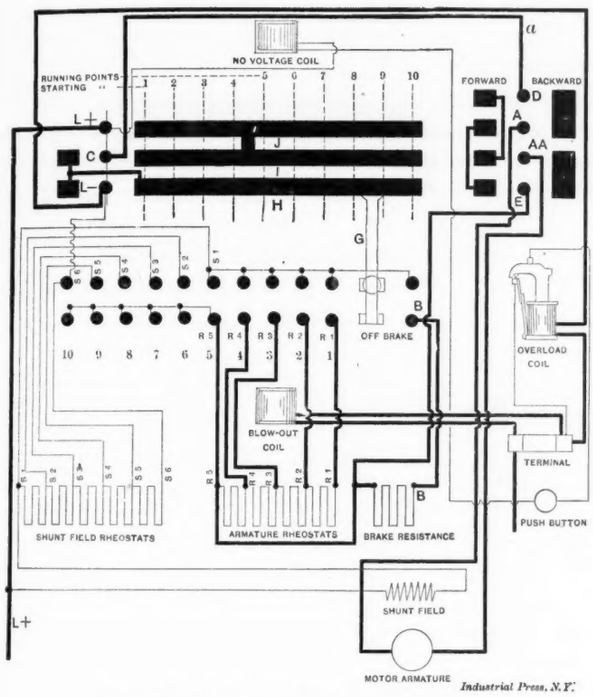



Fig. 4. Type of Controller used for Field Regulation.

cut in or out of the shunt field circuit. For the first four positions of the controller the arm $G$ sweeps over the contacts connected with the armature rheostat, all the latter being cut out of the circuit when the fifth position is reached. By tracing the shunt field circuit from the $L+$ wire it will be seen that after passing through the field, the current flows to the line that connects the top row of $R$ contacts, so that as long as $G$ rests in any of the first five positions there will be no external resistance in the field circuit. When the controller is passed to the sixth position, $G$ will rest on the two contacts, $S2$, and $S1$ will be disconnected, so that the current will have to flow through the field rheostat from point $S1$ to point $S2$, and thus reach upper contact, $S2$. From here the circuit will be completed through $G$ to $H$ and thus through contact $L-$ to the wire leading through the overload coil and the cut-out coil to the $L-$ line wire. By tracing the movement of the controller through the remaining steps it will be seen that at each successive one an additional section of the field rheostat will be cut into the circuit and when the last position is reached all the rheostat will be in circuit, thus giving the weakest motor field.

The rheostat method of control, as already mentioned, provides means for varying the speed by reducing it below the normal velocity, and the variation may be made as great as desired by simply providing sufficient resistance in the regulating rheostat. With this method, the normal motor velocity must be the highest desired. With the field regulating system, the weakening of the motor field by the introduction of resistance in its circuit, acts to increase the velocity, so that the normal motor speed must be the lowest desired.

The field regulating method of control if used with a motor of standard construction will not effect a very wide variation in speed, owing to the fact that before the field is weakened enough to cause a decided increase in velocity, the sparking at the commutator will become excessive. With the general run of motors it is doubtful if the speed can be increased more than one-third without seriously affecting the sparking. The motors used with field regulation controllers are specially designed for the purpose, and are provided with much larger fields and smaller armatures than the standard type. With such motors it is possible to obtain a speed variation of two to one, without producing any noticeable change in the sparking at the commutator.

From the foregoing it will be seen that the range of seeds obtained with field regulation is very much smaller than with the rheostat method, but as an offset we have far greater efficiency and constant velocity at whatever speed the motor may be run.

The appearance of the controller for field regulation, illustrated in the diagram Fig. 4, is well shown in the photographic prints Figs. 1 and 2, the latter showing the contact shield swung out of position so as to show more clearly the stationary contacts $L+$ $L-$ and $C$, and the cylinder rings, $H$, $I$, $J$. It also shows plainly the arm $G$ and the several stationary rheostat contacts over which it sweeps.

* * *

## NOTES ON DESIGN.—2.

### MACHINERY SHAFTING (concluded).

C. F. BLAKE.

A shaft requiring special investigation in certain classes of machines, as cranes, turntables and other revolving machines, is that effecting the slewing or turning in a horizontal plane. Fig. 7 represents the diagram of a common slewing mechanism for a crane, in which

$A$ = the center pin, column or mast,
$B$ = a large circular rack, concentric with $A$,
$C$ = a pinion mounted upon a vertical shaft, and meshing with the rack $B$.
$E$ = a gear, which connects with the slewing shaft,

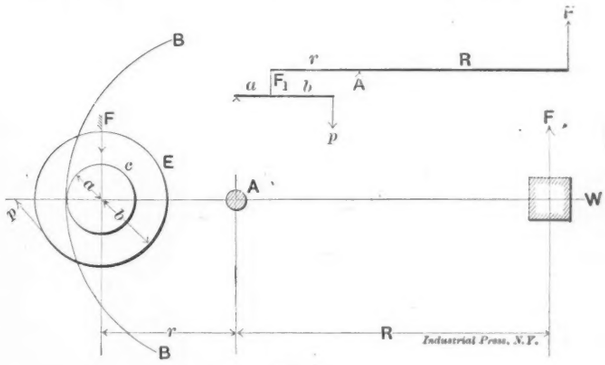



Fig. 7.

$W$ = the load in pounds,
$R$ = the radius of the boom in feet,
$r$ = the radius of the circle of action of the slewing shaft,
$a$ = the radius of the pinion $C$.
$b$ = the radius of the gear $E$,
$n$ = the number of revolutions per minute of the crane,

$V$ = the velocity of the load $W$ in feet per second $= \dfrac{2 \pi R n}{60}$

$$V^2 = 0.01 R^2 n^2$$

$S$ = space in feet in which full velocity is to be obtained,
$F$ = force in pounds acquired by the load $W$,
$F_2$ = force in pounds on the slewing shaft,
$p$ = force in pounds on the pitch line of gear $E$,
$g$ = acceleration, = 32.2,

$$\text{Energy} = \frac{W V^2}{2 g} = F S$$

Then,

$$F = \frac{W V^2}{2 g S} = \frac{W V^2}{6.44 S} \quad \ldots\ldots\ldots\ldots (2)$$

Assuming $S$ = one-quarter of a turn, $= \frac{2 \pi R}{4} = 1.57 R$, and substituting the values of $S$ and $V^2$ in (2) we have,

$$F = 0.001 R W n^2$$

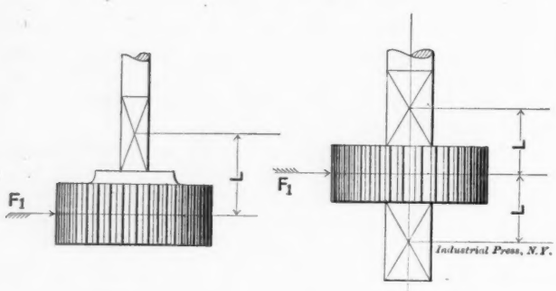



Fig. 8. Fig. 9.

Now

$$F_1 = \frac{F R}{r} = \frac{0.001 R^2 W n^2}{r},$$

also

$$p = \frac{F_1 a}{a + b}$$

Substituting value of $F_1$ in (3) we have

$$p b = T = \frac{.001 R^2 W n^2 a b}{r (a + b)}$$

and

$$k = \frac{M}{T} = \frac{L (a + b)}{a b}$$

**Shaft between Bearings, Fig. 9.**

$$M = \frac{F_1 L}{2} = \frac{.001 R^2 W n^2 a b}{2 r}$$

Substituting value of $F_1$ in (3) we have

$$p b = T = \frac{.001 R^2 W n^2 a b}{r (a + b)}$$

and

$$k = \frac{M}{T} = \frac{L (a + b)}{2 a b}$$

In taking the values of $W$ and $R$, not only the load and the radius of the boom must be considered, but also the weight and radius of such heavy parts of the machinery as may revolve with the crane, in each case resolving the turning moment of such parts about the center pin or mast, to the radius $R$.

Example: Fig. 10 represents a steam crane, the letters corresponding to those of Fig. 7, while the dimensions and weights given are those of a particular crane having a capacity of ten tons at a radius of sixteen feet, the pinion $C$ meshing into an internal spur rack in the foundation and being driven by bevel gears as shown. Required the diameter of the vertical shaft, $f$ being 12,000 pounds per square inch.

| $\frac{R^2}{r}$ | Values of $n$. | | | | | $\frac{R^2}{r}$ | Values of $n$. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| 20 | .00001 | .00004 | .00009 | .00016 | .00025 | 120 | .00006 | .00024 | .00054 | .00097 | .0015 |
| 30 | .000015 | .00006 | .000135 | .00024 | .000375 | 122 | .000061 | .000244 | .000549 | .000986 | .001525 |
| 40 | .00002 | .00008 | .00018 | .00032 | .0005 | 124 | .000062 | .000248 | .000558 | .001002 | .00155 |
| 50 | .000025 | .0001 | .000225 | .0004 | .000625 | 126 | .000063 | .000252 | .000567 | .001018 | .001575 |
| 60 | .00003 | .00012 | .00027 | .00048 | .00075 | 128 | .000064 | .000256 | .000576 | .001034 | .00160 |
| 70 | .000035 | .00014 | .000315 | .00056 | .000875 | 130 | .000065 | .00026 | .000585 | .00105 | .001625 |
| 80 | .00004 | .00016 | .00036 | .00064 | .001 | 140 | .000070 | .00028 | .00063 | .00113 | .00175 |
| 90 | .000045 | .00018 | .000405 | .00073 | .000112 | 150 | .000075 | .0003 | .000675 | .00121 | .001875 |
| 100 | .00005 | .0002 | .00045 | .00082 | .00125 | 160 | .000080 | .00032 | .00072 | .00129 | .00200 |
| 110 | .00055 | .00022 | .000495 | .0009 | .001375 | 170 | .000085 | .00034 | .000765 | .00137 | .002125 |

For $f$ = 12,000 multiply by .833
For $f$ = 16,000 multiply by .625

Table IV. Values of h for Various Values of $\frac{R^2}{r}$ and n.

and the twisting moment on the shaft is,

$$p b = \frac{F_1 a b}{a + b} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Substituting in (3) the value of $F_1$, assuming $f$ = 10,000 pounds per square inch, and equating to the moment of resistance of the shaft to torsion, we have,

$$\frac{\pi}{16} d^3 f = \frac{0.001 R^2 W n^2}{r}$$

$$d^3 = 0.000,000,5 \frac{n^2 R^2}{r} \frac{W a b}{a + b}$$

$$d = \sqrt[3]{h \frac{W a b}{a + b}} \quad \ldots\ldots\ldots\ldots (4)$$

Table 4 gives values of $h$ for various values of the ratio $\frac{R^2}{r}$ and $n$.

The pinion $C$ may be either overhung, or mounted between bearings, as shown respectively in Fig. 8 and Fig. 9. The values of $k$ are as follows:

**Overhung Shaft, Fig. 8.**

$$M = F_1 L = \frac{.001 R^2 W n^2 L}{r}$$

The load at 16 feet — 0 inches radius = ....20,000 pounds.
The block at 16 feet — 0 inches radius = .... 435 "
The jib weighs 3,000 pounds, its center of gravity being at a radius of 11½ feet, resolved to a radius of 16 feet — 0 inches = $\frac{3{,}000 \times 11.5}{16}$ = ..... 2,156 "
The boiler and extension weigh 11,855 pounds at a center of gravity radius of 8½ feet, resolved to a radius of 16 feet — 0 inches = $\frac{11{,}855 \times 8.5}{16}$ = ..... 6,297 "
The machinery and side frames weigh 21,800 pounds, at a radius of 2 feet, resolved to a radius of 16 feet — 0 inches = $\frac{21{,}800 \times 2}{16}$ = 2,725 "

Total load assumed at a radius of 16 feet — 0 inches =.....31,613 pounds.

$$\frac{R^2}{r} = \frac{16^2}{2} = 128$$

Opposite 128 and under $n$ = 3 in the above table, 3 being the required revolutions per minute of the crane in question, the value of $h$ is 0.000576, and since the shaft is to be strained to 12,000 pounds per square inch we have,

$h = 0.000576 \times .833 = 0.00048.$

From (4) we have

$$d = 0.00048 \frac{31{,}613 \times 5 \times 9}{14} = 3.65 \text{ inches diameter for}$$

twisting only.

The pinion being mounted between bearings, we have $L = 6$ inches, and

$$k = \frac{6\,(5+9)}{2 \times 5 \times 9} = 0.93$$

Corresponding to this value of $k$ we find $N = 1.3$ in Table 3 in the last article. Then

$d = 3.65 \times 1.3 = 4.64$ inches diameter shaft required.

When calculating the size of shafting, the first thing of importance to determine is the length of the journal, and once established, all bending moments should be taken to the center of the journal. Given the diameter, the length of the journal depends upon three conditions: Bearing area, character of lubricant, and ability to carry off heat. Grease has become a most widely used lubricant for heavy machinery, possessing as it does sufficient body to enable the designer to use higher bearing values than with other lubricants without squeezing the lubricant from the bearing. It has been found in practice that to limit the surface speed to 350 feet per minute, and the bearing value to 80 pounds per square inch of projected area, produces, with grease as a lubricant, a very satisfactory bearing, well within the limits of good performance as regards heating.

Let $d =$ the diameter of the shaft,

$l =$ the length of the journal.

$a =$ the projected area, $= d \times l$,

$W =$ total pounds pressure on journal.

$R.P.M.$ = revolutions per minute of the shaft.

Then the pressure per square inch is,

$$\frac{W}{a} = \frac{W}{d \times l} = 80 \text{ pounds}$$

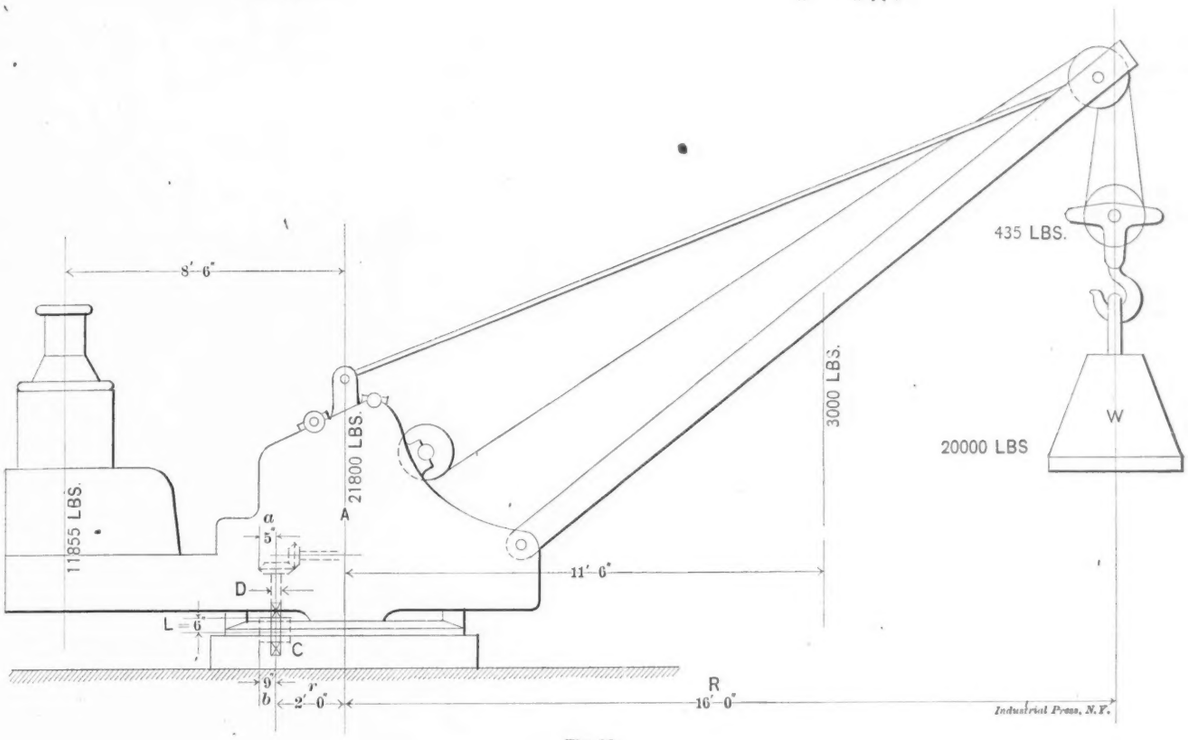



Fig. 10.

$$d = \frac{W}{80\,l}$$

The surface speed is,

$$\frac{\pi\, d \times \text{R. P. M.}}{12} = 350$$

$$d = \frac{12 \times 350}{\pi \times \text{R. P. M.}} = \frac{1337}{\text{R. P. M.}}$$

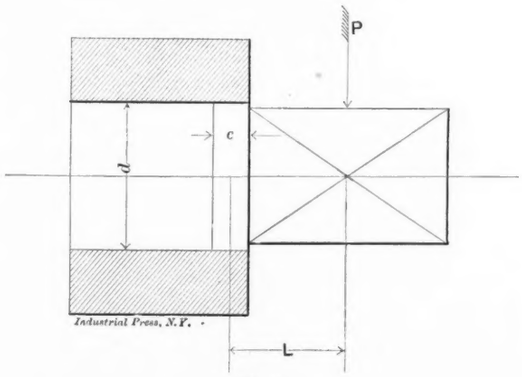



Fig. 11.

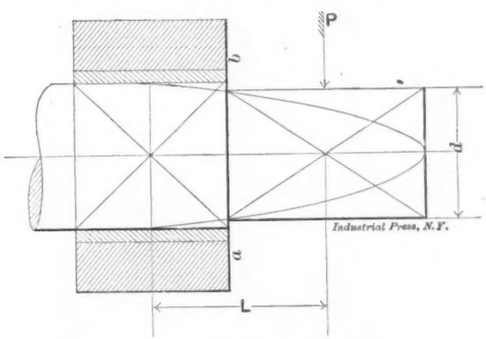



Fig. 12.

Equating these two values of $d$ we have,

$$\frac{W}{80\,l} = \frac{1337}{\text{R. P. M.}}$$

$$l = \frac{W \times \text{R. P. M.}}{106{,}960}$$

and rounding off the constant to a more convenient figure, we have

$$l = \frac{W \times \text{R. P. M.}}{100{,}000}$$

Cases will arise, especially with heavily loaded slow running shafts, in which this rule gives a bearing altogether too short for practice, sometimes not allowing room for the stud bosses on the cap, and also having too high a bearing value, which should be kept below 1,000 pounds per square inch. For shafts running about 80 R.P.M. or faster, the above rule gives excellent bearings, while for slower running shafts an investigation of the bearing value as well as the above rule at once determines the limiting length of the journal.

Chart No. 1 will be found of great convenience in determining the dimensions of journals.

The example shown by the heavy line in the upper portion of the chart, shows that a journal under 650 pounds total pressure, and running 1,250 R.P.M. should be eight inches long. This at once determines the length of the journal and leaves the diameter to be determined by calculating the bending moments to the center of the journal.

The example given in the lower part of the chart shows that a journal 4 inches in diameter and 8 inches long under 5,250 pounds total pressure, will have a bearing value of 162 pounds per square inch of projected area.

A condition frequently met with is that of a shaft forced by pressure into one member, and revolving in another member, as in Fig. 11.

The arm $L$ is determined by laying off a distance $c$ such that

$$\frac{P}{c \times d} < \text{the safe crushing strength of the metal composing the supporting member.}$$

and taking $L$ as the distance from the load $P$ to the center of the strip $c$. It is excellent practice to provide slight shoulders wherever practicable, against which to key the gears, thus locating gears definitely for the assembling workman. Frequently a heavily loaded pinion demands a smaller shaft than the foregoing rules require, in order to leave sufficient

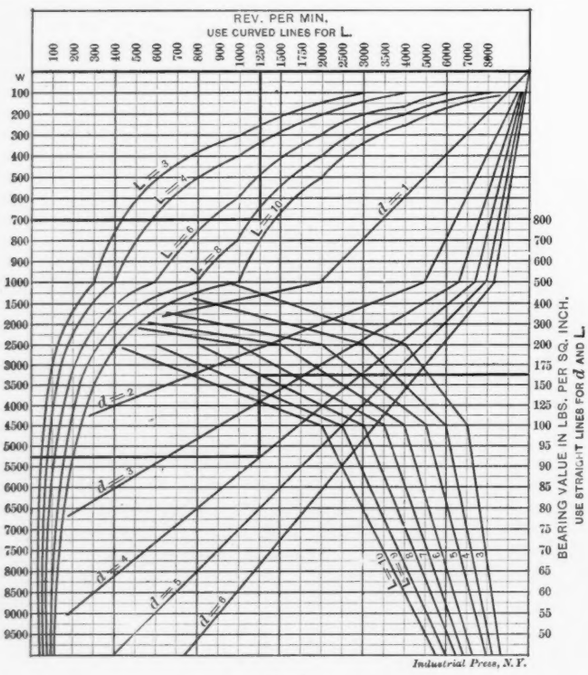



Chart I.

metal over the key. This may be accomplished by making the diameter $d$ at the section $a$ — $b$, Fig. 12, coincident with the diameter of a parabola drawn from base $D$.

A most convenient solution of this problem is offered in Chart No. 2, which also solves at a glance all problems regarding shaft diameters to withstand any combination of moments. The shaft shown at the top is worked out in the chart by following the dotted lines. The shaft is subject to a bending moment of 247,500 inch-pounds, and a twisting moment of 165,000 inch-pounds, hence $k = 1.5$, also $f = 9{,}000$. Enter the chart at the left at 165,000 inch-pounds and follow dotted line to the $f = 9{,}000$ line, thence up to the $k = 1.5$ line, thence over to the right, and read diameter of required shaft on the scale, 6¾ inches. It is now required to find the smallest permissible diameter for the end of the shaft according to the dimensions given. Follow the line marked 15 in the extreme left-hand column to first intersection with the line for 6¾ inches from the scale at the bottom

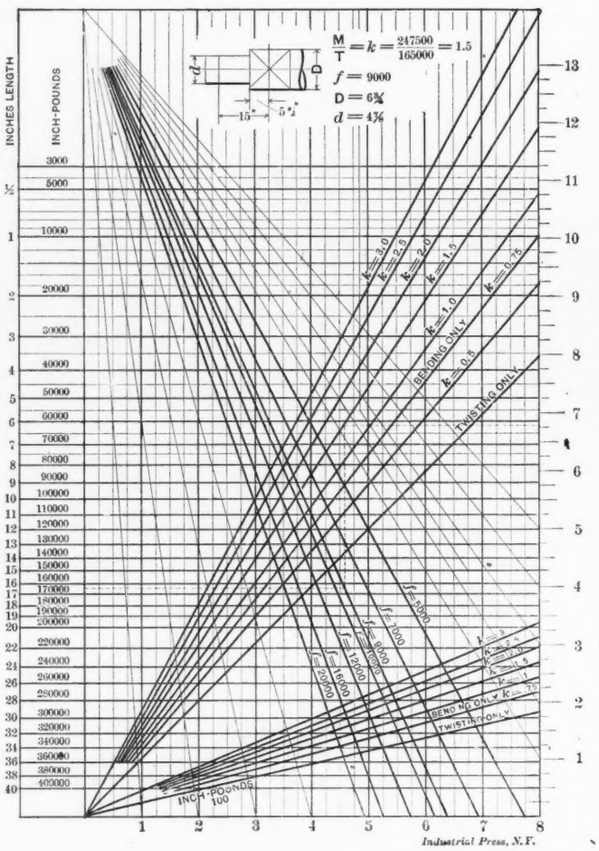



Chart II.

of the chart, thence diagonally to the line marked 5½ at the extreme left, thence up, and read the required diameter on the scale at the top, 4⅞ inches.

For shafts subjected to simple bending or simple twisting moments use the lines so marked instead of the $k$ lines. The set of lines marked $\frac{\text{inch-pounds}}{100}$ are to be used for smaller shafts by dividing all readings in the column of inch-pounds by 100. This makes the range of the chart from 30 to 400,000 inch-pounds.

* * *

## AN ELECTRICAL METHOD OF STRAIGHTENING WIRE.

Amongst the various ingenious temporary expedients which the writer has seen employed in electrical works he calls to mind a method of straightening badly kinked wire which is probably unique. Some old armature wire had been thrown on one side as only fit for the scrap-bin, but it happened to be just the gage required for a particular purpose in the test-room. The following method was therefore adopted to straighten it: One end was attached to a wooden bench and the other fastened to a stout piece of wood which was held by an assistant. A large current was then sent momentarily through the wire from a set of accumulators and at the same moment the assistant gave it a good sharp pull, the result being a beautifully straight piece of wire. It was no doubt reduced in diameter, but so slightly as to be practically immeasurable.—*Page's Magazine.*

* * *

Ignorance sometimes brings bliss, but more often it brings blisters.—*Ryerson's Monthly.*

## A MASSIVE GEAR PLANER.

The machine shown herewith was built by the Gleason Works, Rochester, N. Y., for the Cambria Steel Co., of Johnstown, Pa., and is the design of Mr. Wm. Gleason. As shown in the end elevation, Fig. 1, the mandrel which carries the work, revolves over a pit. The gear to be cut, revolving with the work mandrel, may extend below the level of the base of the machine. The actual capacity of the machine might be said to be much larger than 20 feet diameter. In fact the diameter capacity would be only limited by the amount of error that could be allowed in the dividing of the teeth. On actual test the indexing mechanism divided the teeth on a 15-foot gear within a limit of .0015, which is much finer than actual practice requires. The dividing wheel is 9 feet in diameter and the indexing is done by power. A wheel 30 feet in diameter can be cut by making the pit under the machine deep enough and moving the work carrying spindle over to its extreme position.

The rear view of the machine, Fig. 2, shows the rectangular hole in which the bar operates, that draws the tool slide. It will be noticed that this bar has been placed as nearly directly in line with the cutting point of the tool as practicable, the object being to produce a powerful steady motion for the cutting tool.

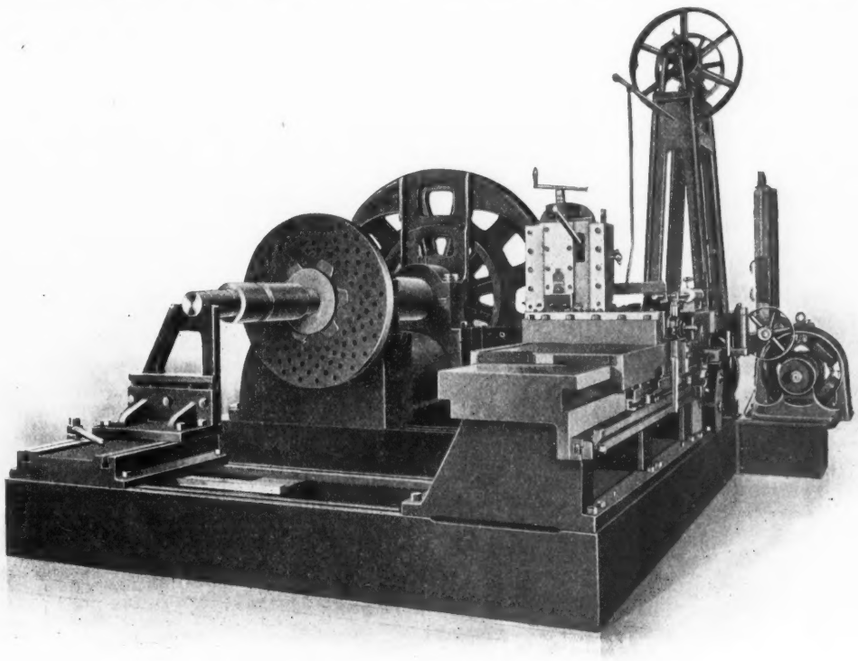


Fig. 1. Large Spur Gear Planer.

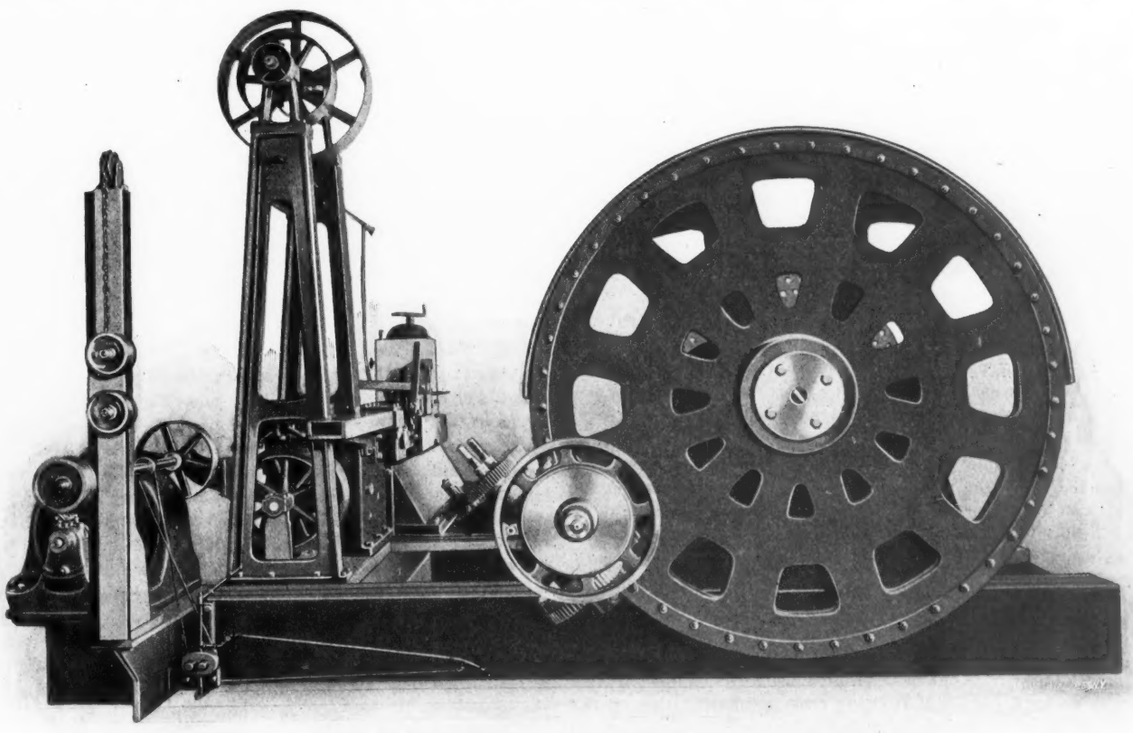


Fig. 2. Gear Planer for Gears up to 30-feet Diameter and 12-inch Pitch.

The power is obtained from a 15-horsepower motor which drives a countershaft placed on top of the standards, as shown in both views, and from the countershaft to the shaft directly below it. The connection is by means of the familiar open and crossed belts with shipper motion, as used on iron planers.

The large steel gear castings for the cutting of which this gear planer was designed have very rough surfaces on the teeth as they come to the machine. For this reason it is necessary to rough-cast the teeth in order to save metal and insure good castings. Some of the gears to be cut are 12 inches circular pitch. Sand spots and hard scale are very hard on the cutting tools, and planer tools, guided by a former, have been adapted to do this work. The roughing tools are not expensive to keep in order and they cut under the scale and rough surface. These tools can be operated at high speeds and coarse feeds when roughing out.

A forming tool is used to remove the tool marks left by the single-pointed roughing tools, except in the case of the very coarse pitch gears, such as the 12-inch circular pitch, in which case the surface of the teeth have to be finished entirely by the single-pointed tools guided by formers. It has been found necessary to finish these coarse pitches with the single-pointed tool because the large amount of surface to be covered makes it better practice to break up the cut in order to reduce the thrust on the cutting tools.

With the machine was furnished a 20-degree involute interchangeable set of spur gear formers, by which gears can be planed ranging from 10 inches diameter to the full capacity of the machine. Each former is stamped for the pitch diameter on which it is made. A pair of formers, one for the top and one for the bottom side of the tooth, will plane gears from the smallest pitch up to a pitch using the full length of the curve. A pair marked for 30 inches diameter would cut any gear 30 inches diameter, 4 diametral pitch to 6 inches circular pitch exactly right.

The gear blank is supported by a thrust brace at the rim, to resist the thrust of the cut; and the pressure of the brace is released each time the gear is indexed, and again applied after the gear has come to a stop and before the tool starts to cut.

The weight of this machine is 80,000 pounds.

* * *

## EARLY AUTOMOBILING.

Mr. Oberlin Smith, president of the Ferracute Machine Co., tells of an early experience in automobiling in a recent number of the *Electrical World and Engineer*. Upon a certain occasion over forty years ago he entered into an "autoing" collaboration with another boy, who is now a distinguished professor of mathematics, both being fired with enthusiasm to emulate the recorded performances of the occasional steam carriages appearing in England from Sir Isaac Newton's time into and through the eighteenth century.

Instead of building such a vehicle entire, the boys procured a farm engine of about 5 horse power built in the general style of a steam fire engine, that is, with a vertical boiler at the rear, fired from behind, and a horizontal engine lying upon the framework in front. They soon realized the difficulty of steering by swinging the front axle with sufficient power and delicacy should either wheel strike an obstruction. This they overcame somewhat ingeniously by fastening ropes near each end of the axle, which came upward and rearward to the main shaft of the engine, being wrapped loosely two or three times around the same, on the principle of a "snubbing post." These ropes continued upward to the hands of the steersman, and with them he could control the axle perfectly by tightening one or the other more or less, the power to hold it against obstacles at either wheel being, of course, supplied by the engine as a rope tightened upon and grasped the shaft thereof.

Upon the first trial one of the rear wheels was connected with the engine by a wide belt running from a small pulley on the end of its shaft to a very large one bolted to the spokes of the wheel, which thus served as the only "driver." In their haste to get the machine under way they waited not for good weather, but started upon a rainy day with the ground covered with slush. The belt soon got wet and the "auto" was held up for repairs.

For the next trial a chain and sprockets (not easily procurable in those days) were substituted for belt and pulleys. The machine itself ran well in spite of having only one driver, but, time still being precious in the eyes of the adventurers, the next start was made over a very bad road covered with snow two or three inches deep. This road was narrow and crooked, soon reaching a narrow wooden bridge spanning an icy river, then running up a hill at a moderate grade. To avoid delay, no connection was made at this first trial from the throttle valve (an ordinary 1¼-inch steam cock) at the rear of the boiler to the driver's seat in front, where he might have attended to it had not both hands been busy with the steering ropes, and both feet with bracing himself to keep him in his seat.

The professor was kindly allowed the honor of the first trial and when duly mounted yelled to the small boy who acted as fireman (standing upon the ground) to turn on steam, which then stood at high pressure. Being both obedient and strenuous, this youngster revolved the cock handle suddenly through an arc of some 90 deg., then letting it slip off and fall hidden in the snow as the machine bounded forward and left him standing in amazement at the ambition thereof.

Young Smith, who was acting as general traffic manager, rushed into the shop wildly searching for a monkey-wrench and triumphantly emerged in chase of the lost auto car, which the powerless chauffeur had by that time succeeded in steering at full speed around the turns of the road and between the railings of the bridge—rather than down a steep bank into the river below. As he reached the hill beyond, with the car ascending and the steam pressure descending, the monkey-wrench and the boy he left behind him succeeded in reaching the steam-cock, and everything ended happily. The machine not afterward proving comfortable enough for a touring car was classed in the grade of runabouts, in view of the performances it had given. Later on it became a stayabout.

In contrast, Mr. Smith says of future automobiling: "To bring about halcyon days of pleasure travel, two important new conditions are necessary. The first is to have a cheap, light and durable storage battery. The second will consist in the establishment of a system of electric charging stations upon our streets, roads and waterways. The improvement of the storage battery will vitally affect the running of automobiles and pleasure boats which are now run by their owners and chauffeurs under conditions of martyrdom."

* * *

## COMPRESSED AIR EXPLOSIONS.

It is a pretty well-established fact that a compressed-air system, *i. e.*, the compressor, receiver and pipes, has within itself the potentiality of destructive explosion if the matter of air-cylinder lubrication is indifferently attended to. That is, if lubricating oil of low flash-point is fed into the air cylinder of a single-stage compressor working against a pressure of say 80 pounds per square inch or more, the practice is fraught with danger, but there is an element of mystery in some of these explosions that has not been made exactly clear. Theoretically it can be shown that if low flash-point lubricating oil is fed into a compressed-air system it may readily form an explosive gas, and the heat generated in compression under certain conditions might suffice to fire the charge. But such explosions are rare, although the conditions found in many cases seem to invite such a disaster. In a paper read by Mr. R. Jordan before the South Wales Institute of Engineers a compressed-air system explosion was described in which the air cylinders were lubricated with a mixture of soft soap and water—2 pounds of soap to 1 gallon of water—and the hinge bars of the valves with "Valvoline" oil. About two gallons of the soap mixture and two quarts of the oil were used in twenty-four hours. The air cylinders of the compressor were 26 inches diameter and 42 inches stroke and the air pressure was about 60 pounds. The damage done in this case was not serious; the system was in a colliery and no one was hurt. The explosion is attributed to no particular condition, but certain causes were laid down that might have contributed to the wreck. Coal dust drawn in with the free air combines with the oil and soap suds and

forms a solid deposit which when heated gives off an explosive vapor. It has been shown that coal dust alone will ignite at a temperature of 291 degrees F., and in the vicinity of a colliery it is conceivable that if the intake pipe was carelessly located there might be sufficient accumulation of dust to become explosive in the receiver. The temperature of compression is not ordinarily high enough to fire a charge, but if the piston is allowed to run dry or if the discharge valves or pipes become choked with accumulations the temperature of air discharged from the cylinder might easily pass the danger point. The frequent removal of all solid and liquid deposits from air-compressors is advocated, especially where carbonaceous dust is taken in with the free air. Obviously the intake should be located where the air will be pure and cold as possible.

* * *

## THE R. K. LE BLOND MACHINE TOOL COMPANY'S SHOP.

In previous issues we have referred to the growth of the machine tool industry in Cincinnati, Ohio, a city which now occupies the leading place in the United States in the manufacture of lathes, planers, milling machines, shapers, drills and other machines for working metals—to say nothing of the great factories engaged in the manufacture of woodworking tools. As also previously mentioned, most of the newer shops are located in the Mill Creek valley district, and in the September, 1902, issue a map of this section was published showing the location of the various shops embraced by it. The large shop of The R. K. LeBlond Machine Tool Co., however, is located on the opposite side of the city, on Eastern Avenue, and the location and shipping facilities appear to be equal to those of the more favored district.

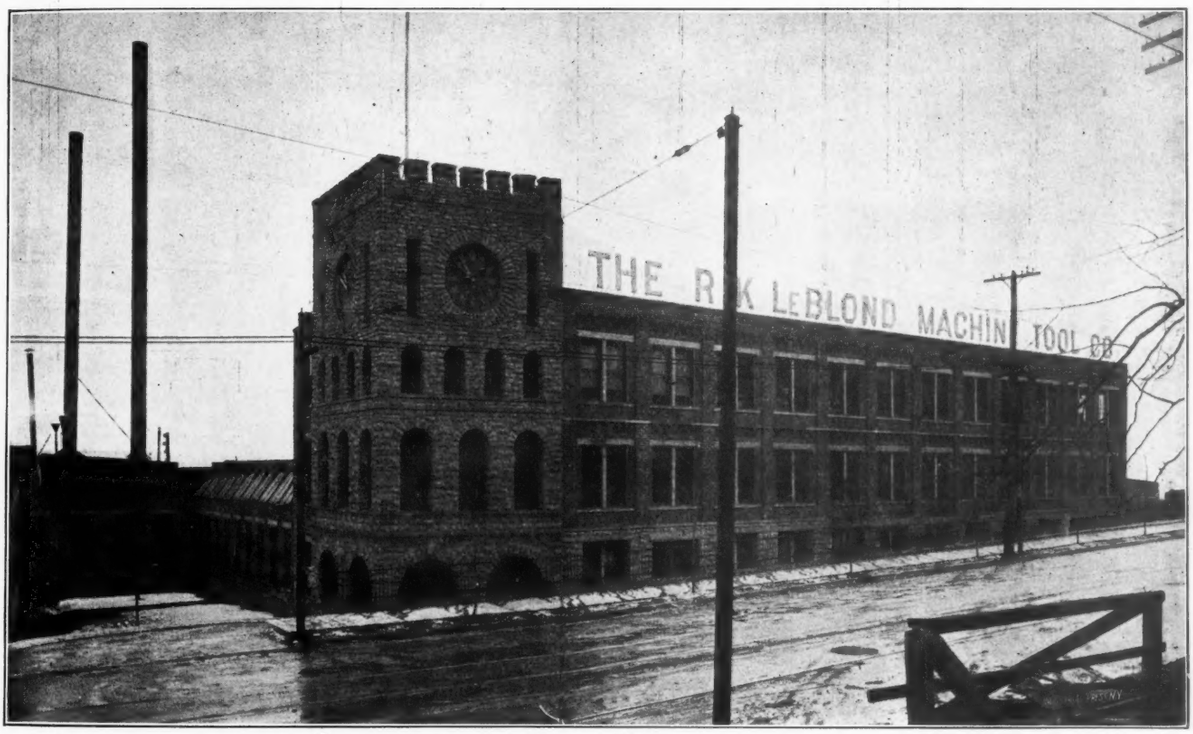



Fig. 1. General View of The R. K. Le Blond Machine Tool Company's Shop.

This shop was built about five years ago, and is quite unique in its general plan and arrangement. The general view, Fig. 1, shows the three-story front section and tower; at the far end of the three-story front section a three-story wing extends at right angles, forming an "L." The "L" is indicated in the plan, Fig. 2, by the full and dotted lines, *A*, *B*, *C*, *D*, *E*, *F*. The remainder of the plan is one story high, with basement under part of it, which is utilized for storage purposes. Extending to the north is the one-story engine room, boiler room and blacksmith shop. This and the side of the one-story machine shop section may be seen in Fig. 1, at the left. The roof of this latter section is of the saw-tooth variety, having four sections or gables, and general interior views of it may be seen in Figs. 8, 9 and 10. In the plan, Fig. 2, a pier is indicated by the dotted lines, *G*, *H*, *J*, *K*, upon which are located the planers. This pier, of course, is built up level with the shop floor, and is surrounded by masonry retaining walls. The earth within the walls was tamped down solidly and the top was finished off with a layer of concrete. The planers are thus given a solid foundation entirely independent of the shop structure or foundation walls. The basement on the east and west sides of the pier is used as storage spaces for patterns, castings, etc. The basement space adjacent to the pier on the east is utilized for the storage of steel bar stock, and power hack-saws are set up there for cutting the stock into lengths as required. Beyond this section is the basement of the three-story wing section which is used as a washroom and storage for bicycles. This room is very comfortably fitted up with sanitary conveniences and each man has an individual locker bearing a number which is his check and payroll number. The floor is concrete.

The boiler house also shelters the blacksmith shop. This is equipped with casehardening furnaces, steam hammer, etc. The engine room adjacent contains the main engine connected to the lineshaft by belt, and a direct-connected engine and electric generator. The method of transmitting power from the main lineshaft to the parallel lineshafts is indicated in the plan, Fig. 2, and illustrated in Fig. 13. On each side of the main pulley are located narrow face pulleys for transmitting motion to the next lineshaft. In this way the pull on the main lineshaft is partially balanced, and by having a pulley on each side of the main pulley the balancing tendency is equalized on each side of the main pulley.

The lineshafts run on Hyatt roller bearings and throughout the five years of use they have given good satisfaction. As shown in Fig. 13 the hangers are made so that they may be readily adjusted vertically, being clamped to pipe sections which in turn are secured to the roof. Tension rods secure them laterally, and these are adjustable so that any box requiring change of location can be moved up or down, or sideways, or both, as may be necessary.

The main entrance is in the base of the stone tower and is partially hidden in the general view, Fig. 1, by the street

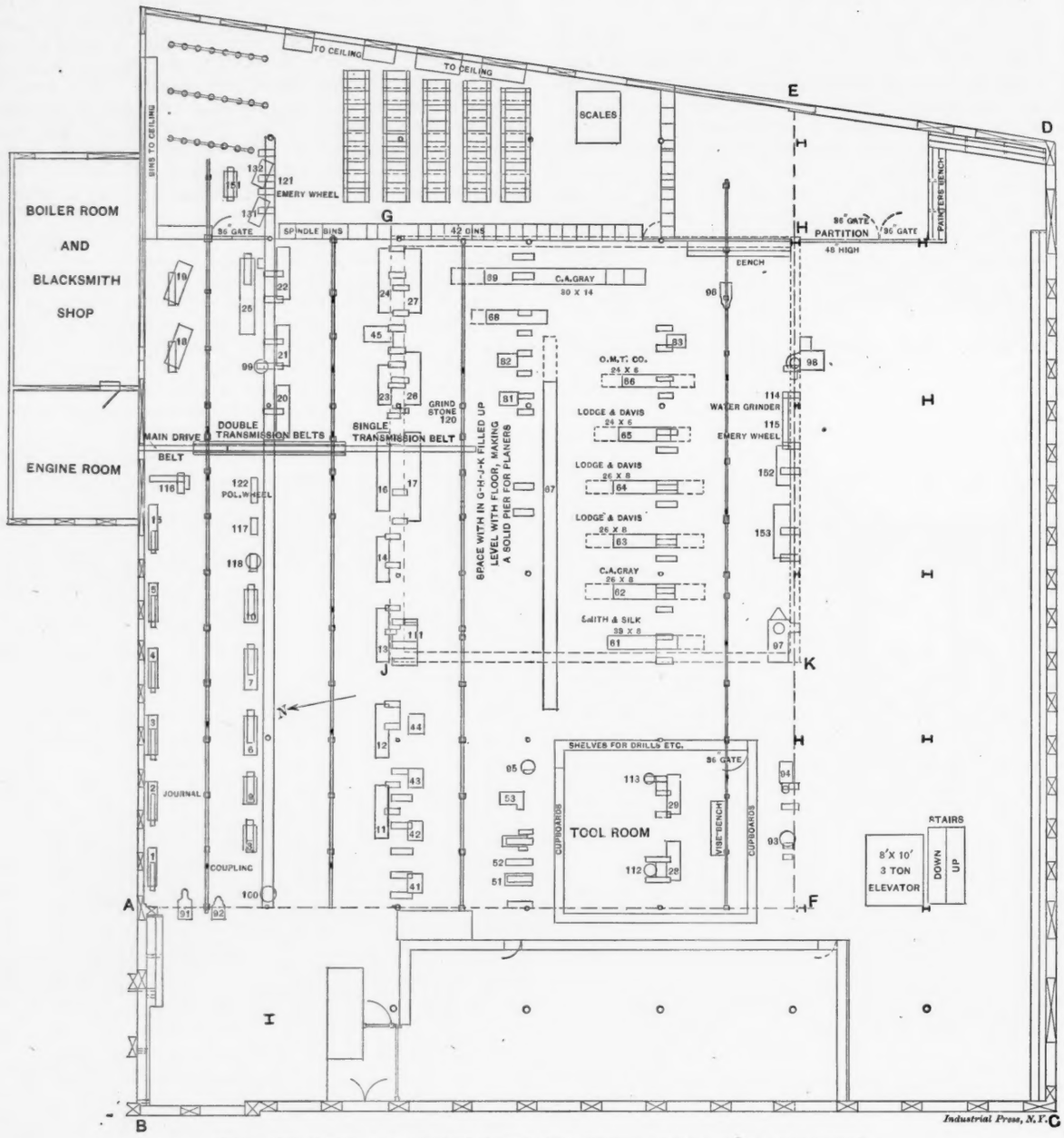



Fig. 2. Plan of Shop, R. K. Le Blond Machine Tool Company. Scale: 1 inch = 23 feet nearly.

grade, which was raised several feet after the shop was built and which accounts for the apparently low position of the building. The general offices are on the second floor of the tower section and the private dining room for the officials of the company is on the third floor of the tower. A view of the private dining room is shown in Fig. 16. The top floor of the tower is occupied by a Seth Thomas clock with striking attachment.

The drafting room is on the second floor, about midway of the front section, and is partly shown in Fig. 4. All drawings are made in pencil on bond paper and inked in. The sizes used are 12 x 18 inches, 18 x 24 inches, and 24 x 36 inches. When inking in a drawing the practice is to spread an old blueprint on the board beneath the paper, which relieves the glare from the bond paper. The blueprints are printed from these drawings in the usual manner and practically as good results are obtained as with tracings on cloth. Blueprints for the shop are mounted on heavy strawboard and shellacked over. When a blueprint becomes dirty or damaged it is destroyed, together with the strawboard back. When a workman gets a blueprint he gives a check and the number of the drawing is written with pencil on the back of the check, which is hung on the hook from which the blueprint was taken. In this way the location of a blueprint can be discovered by an inspection of the check. When a blueprint becomes obsolete it is marked "Discarded," together with the date, and is filed in special drawer reserved for the purpose and the original drawing is also taken from the file and

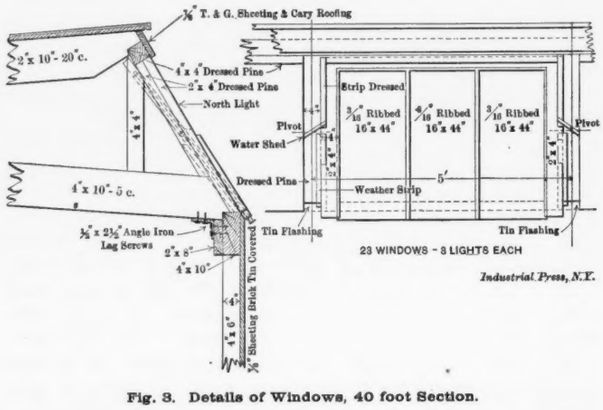



Fig. 3. Details of Windows, 40 foot Section.

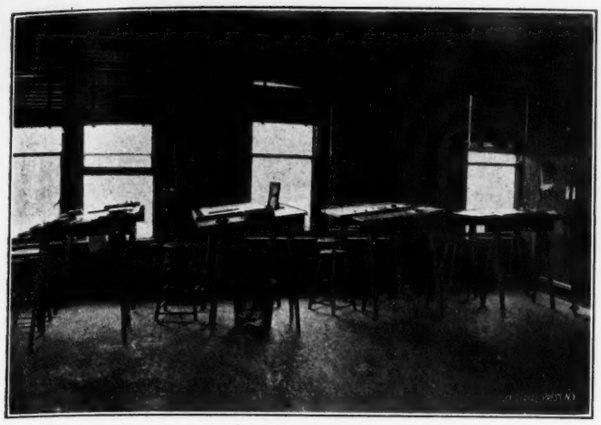


Fig. 4. Drafting Room.

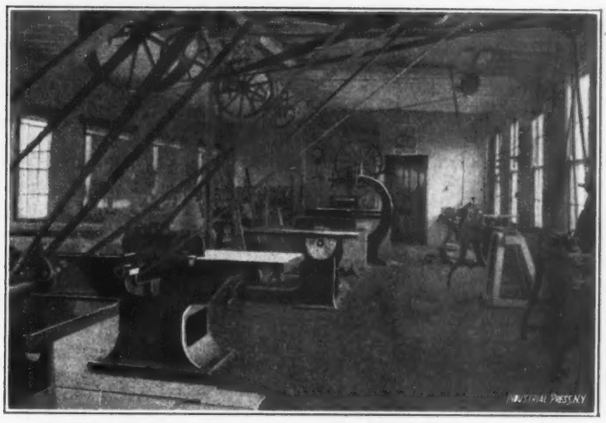


Fig. 5. Pattern Shop.

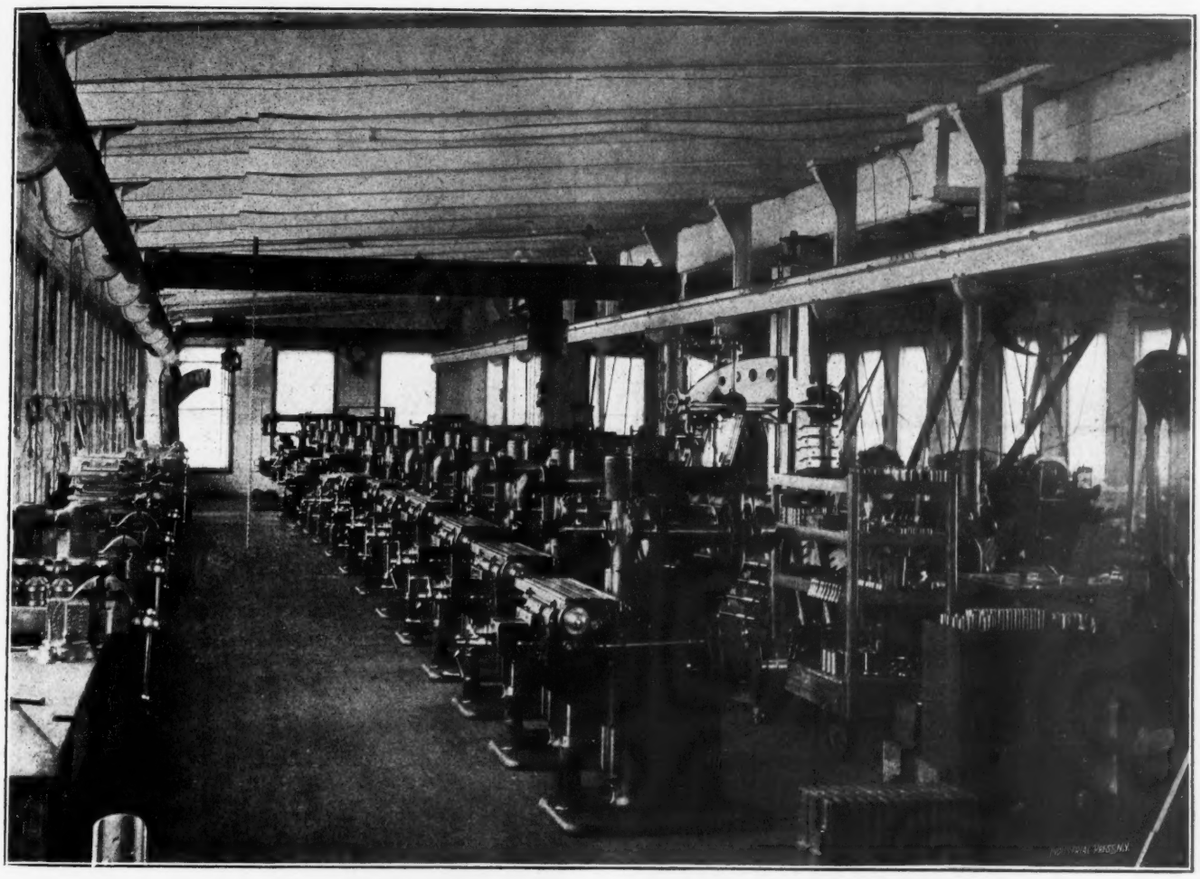


Fig 6. Milling Machine Erecting and Fitting Department.

Fig. 7. Small Lathe Assembling Department.

Fig. 8. Manufacturing Tool Room.

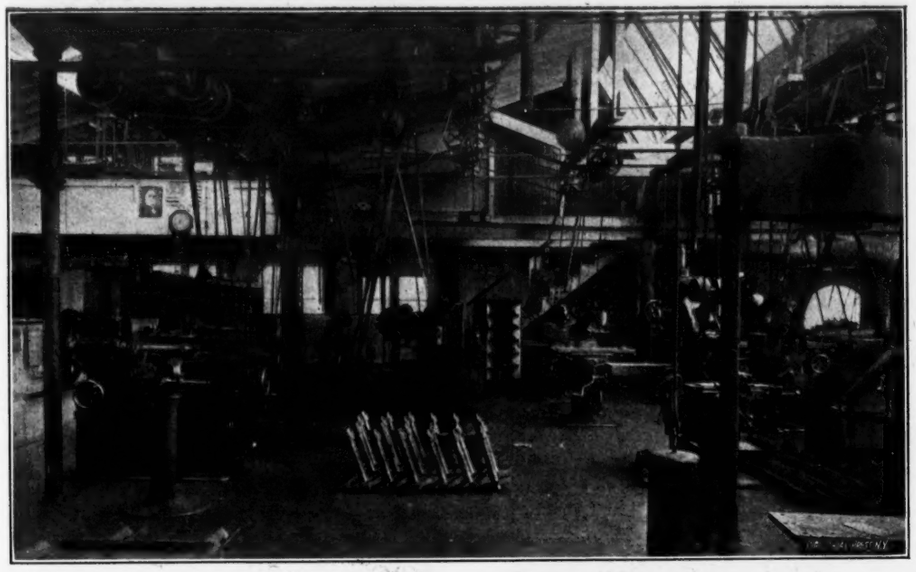


Fig. 9. Gear Cutting and Milling Department.

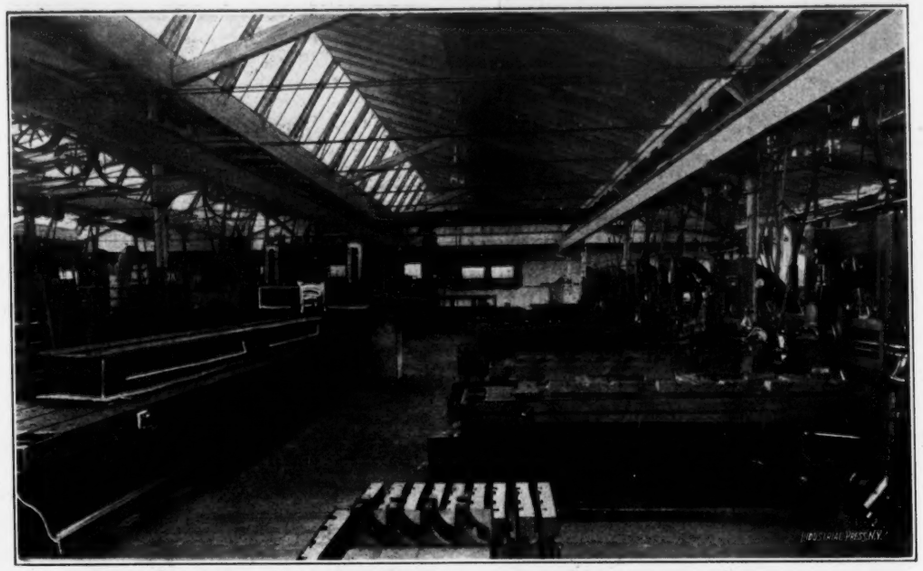


Fig. 10. Planing Department.

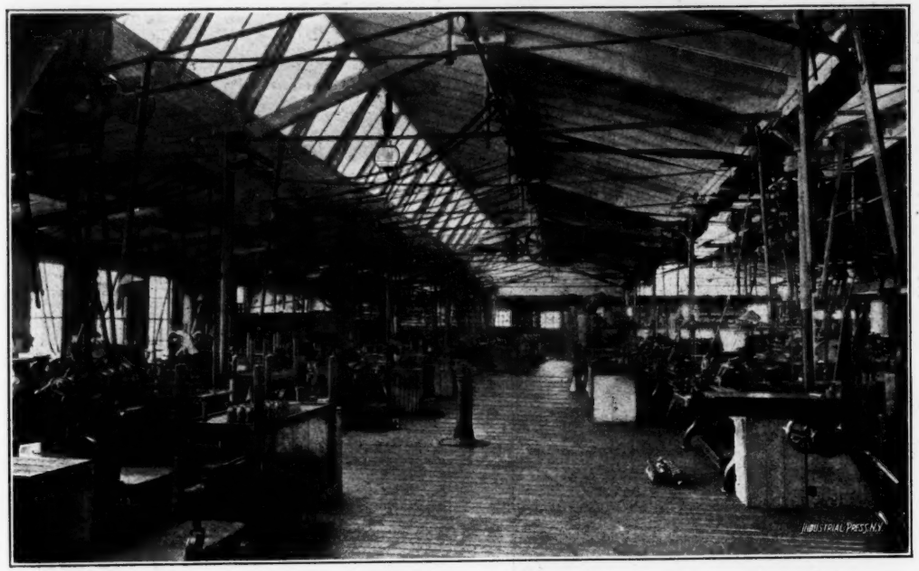


Fig. 11. Lathe Department.

Fig. 12. Large Lathe Erecting Department.

placed in the discarded file. Blueprinting is done by sunlight, a frame being provided which slides out upon the roof. This frame is something of a novelty, inasmuch as it is so constructed that the glass automatically lifts from the paper when the frame is drawn in, thus enabling the print to be removed and another paper substituted quickly. This is done by the glass frame riding up on an inclined way as the frame is pulled in and, of course, when the frame is pushed out again the glass descends and holds the copy and blueprint securely.

The location of the main toolroom is indicated in the floor plan, Fig. 2. A great variety of gages and jigs are provided, as becomes a shop in which manufacturing is done on the interchangeable plan. Part of the gages are kept in four-sided revolving cases standing out on the toolroom floor, which arrangement makes for the convenience of the tool-

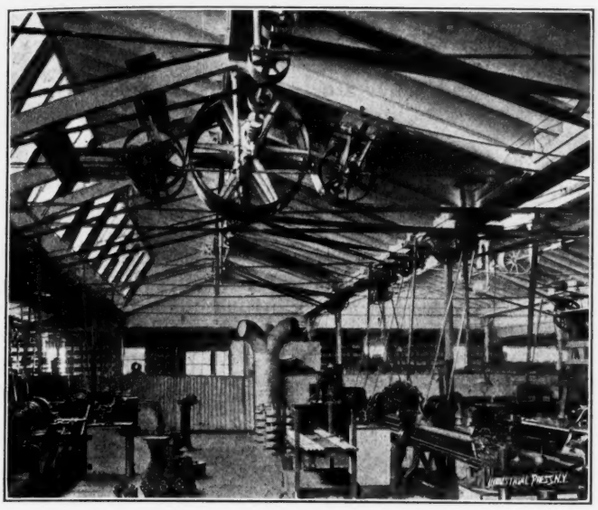


Fig. 13. Main Line Shaft and Belt Drive.

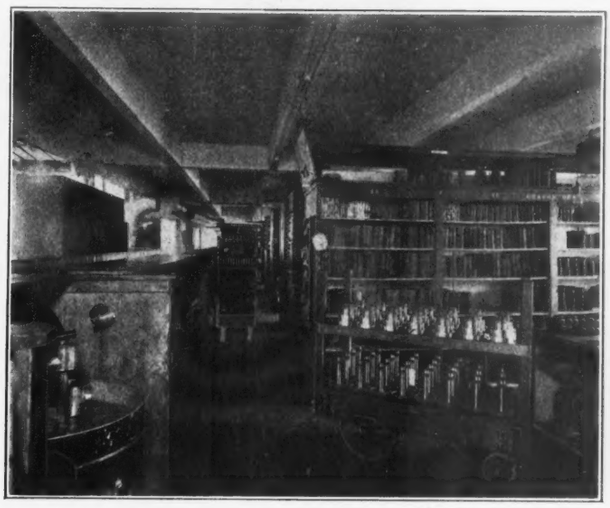


Fig. 14. Stock Room.

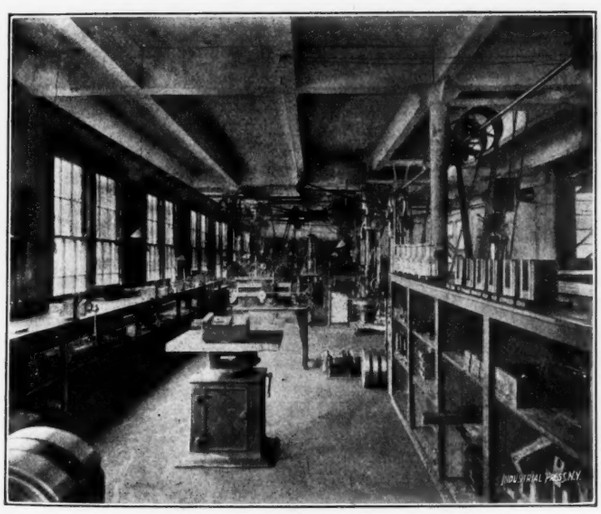


Fig. 15. Experimental Department.

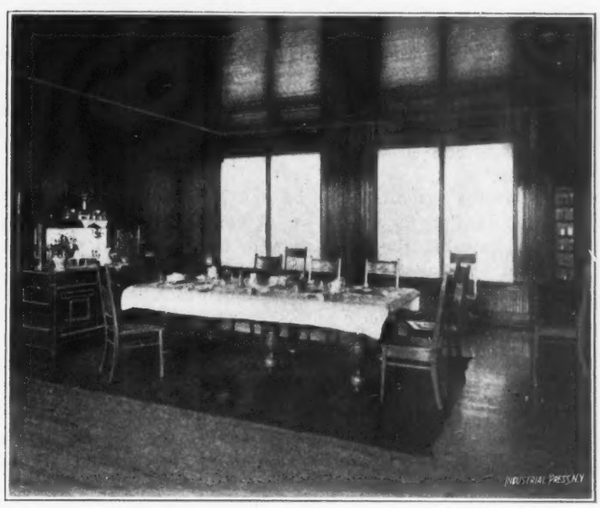


Fig. 16. Private Dining Room.

room attendant. All tools, of course, are given out on check and strict account is kept of this valuable and indispensable part of the shop equipment. Micrometers also form a part of the toolroom gage and measuring apparatus, and are given out on check the same as other gages. The stock of special tools, such as cutter bars, reamers, end mills, special mills, etc., is large, being so not only because of the necessity of duplication but also because of the variety of the work and the extent to which the interchangeable feature of the manufacture is carried out.

The machine tool equipment embraces a number of special machines of which the index-plate drilling machine illustrated and described in the March, 1904, issue is a good example. Another interesting machine, but of a simpler order, is a machine for milling the faces of cone pulleys. A cut of this machine is not shown, but its principle is simple enough to be made clear without it. The work spindle carrying the pulley stands at right angles to the cutter spindle, an inserted cutter end mill being used. Both spindles are in horizontal planes. To mill an approximately flat face pulley the projected cutter spindle axis should pass through the vertical middle plane of the pulley and it should be raised (or depressed) so that the teeth sweep arcs on the face of the pulley at the end of its horizontal diameter. But now if the cutter be depressed a short distance, its alignment and that of the pulley remaining the same, the cutters cut a rounded face on the pulley as it slowly feeds around, the reason being that the cutters as they sweep arcs over the pulley face are nearer the pulley center when at the sides than when over the center of the face.

All planer work is jigged, the fixtures being of the simplest form. Clamps with tapered horns engage the cored holes of lathe headstocks and tailstocks for the first planing operation, which insures that the cored holes will be concentric with the casting when being bored. The planers, as already stated, are mounted on a masonry and concrete pier, which insures them a solid and permanent foundation. A further precaution to insure a solid and equal support all around is the use of small sole plates or shoes with wedges operated by screws. One of these is placed under each planer foot, thus giving the immediate means of leveling up if necessary. Fig. 10 shows a portion of the planing department with the planer for long lathe beds at the left.

Lathe leadscrews are cut in a special lathe fitted for the purpose which cuts chips from the screw with the carriage

coming or going. The special tool-holder used on this lathe, is shown in Fig. 17. There are two tools in front and two at the back, the front tools being in operation, of course, when the work is running forward, and the rear tools being used when the work is running backwards. In this way no time is lost running the carriage back to take a fresh cut. The screw is deluged with lubricant so as to maintain the lowest possible temperature consistent with the rapidity of the work. Each pair of tools is disposed in the holder so that one tool cuts the stock away from the bottom of the thread while the other attacks the side toward which the carriage is traveling.

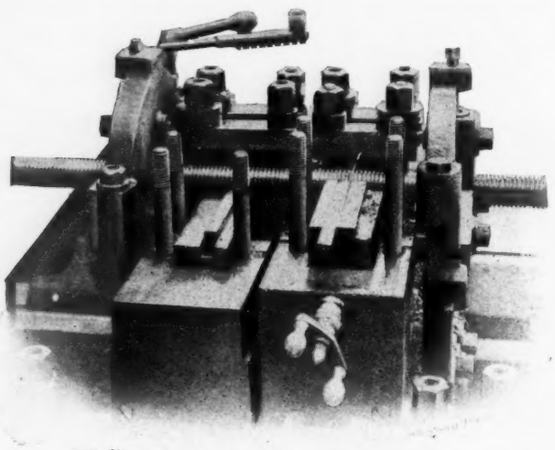


Fig. 17. Special Tool Holder for Cutting Lead Screws.

The production of leadscrews cut in this lathe is said to be quadruple that of an ordinary machine, and much more accurate.

The bearings of lathe headstocks are bored on a horizontal boring mill with the headstock held in jig having large bearings in line with those being bored. These jig bearings are provided with bushings which turn with the boring-bar, being keyed to same, so that the latter is free to feed through them. The connection of the jig boring-bar is made to that of the boring machine by means of a universal joint so that the alignment of the boring-bar is in no way affected by the set up of the jig on the boring mill table. Substantially the same rig is now used by most of the lathe builders of Cincinnati.

The milling machine erecting and fitting department is illustrated in Fig. 6; and a set of boring tools and reamers used in finishing the main spindle bearings, also the back gear and overhanging arm holes, is shown in Fig. 18. A large cast-iron jig embraces the frame which is tipped down, as shown in Fig. 18, on a special truck used for the purpose. In this position the radial drill seen in Fig. 6 is employed to drive the bars for boring and reaming. The bars are supported in revolving bushings the same as in the lathe headstock jig, that is, so that they revolve with the bar and prevent wear of same. The connections of the bars with the spindle of the drill are of a flexible or semi-universal joint order, making the alignment of the bar absolutely dependent upon the jig. It will be observed that all three holes are finished at the same setting, perfect parallelism being thus assured.

Great care is taken in the details of the main spindle and its fitting. The spindle journal next the nose consists of a hardened steel bushing, tapered exteriorly and ground after being pressed on the spindle. This hardened bushing runs in a cast-iron bushing pressed into the frame and held by a nut. The wearing durability of this combination is said to be unsurpassed if it receives ordinary care. While cast iron is prone to cut with soft steel journals it has very little tendency to do so with hardened journals. The spindles of the smaller milling machines are aligned with the knee and table so that they are "out" 0.001 inch downward and the same amount sideways when new, the idea being that by the time they are in good working order the side thrust due to the feed and the vertical thrust will have practically corrected the error. The practice is one that is said to work satisfactorily, as it insures a longer period of approximate perfection than would be the case if the parts were perfectly aligned in the beginning. This is self-evident.

There are so many mechanical practices and devices of which it would be interesting to speak, but which are barred because of space, that it is somewhat difficult to select representative examples. The manufacture of the milling machine and its accessories is of particular interest. Special attention is given the construction of the index head. The wormwheels are cut in a fixture which rotates the wormwheel positively while being hobbed and the master wormwheel is of large diameter to reduce the error of division to the minimum. After being cut they are "jacked" to rub down the slight roughness caused by the hob. The parts of dividing heads as well as the other parts of the machines are made strictly on the interchangeable plan.

In the screw machine department the system of making forming tools is worth a special description and this we may take up in a future article. A circular templet is first turned in the lathe of the same contour as desired on the work. A longitudinal groove is then milled with one side radial. This forms an accurate templet to which the tool can be fitted. It will be appreciated that in turning the templet in the lathe the operator has at his command the use of the compound rest by which angles of any degree can be laid off exactly, faces can be made absolutely square with the length and measurements made with micrometric exactness. Templet making, ordinarily a difficult and inaccurate process, is thus quite simple and great accuracy is readily attained. Many gang-tools are made in the same manner. For instance a gang cutting-off tool is used for making washers. Four washers are cut off at the same time, one following the other in being severed from the stock, of course. Of a certain size four washers are cut off in 4½ minutes where it formerly took 3½ minutes to cut off one. Cleveland screw machines are used. A troublesome feature of screw machine work is the chips and the separation of the oil. In this department the chips are shoveled into a large galvanized tank (about 2 x 3 x 4 feet) on wheels, which has a false perforated bottom. The chips are cleaned out of the chip pans at night and are shoveled into the tank, which can be conviently hauled around for the purpose. During the night the oil drains into the bottom leaving the chips quite dry the next morning. They are then "whirled" in the centrifugal separator to recover the small amount of oil still adhering. This practice is said to work a considerable economy in saving of oil.

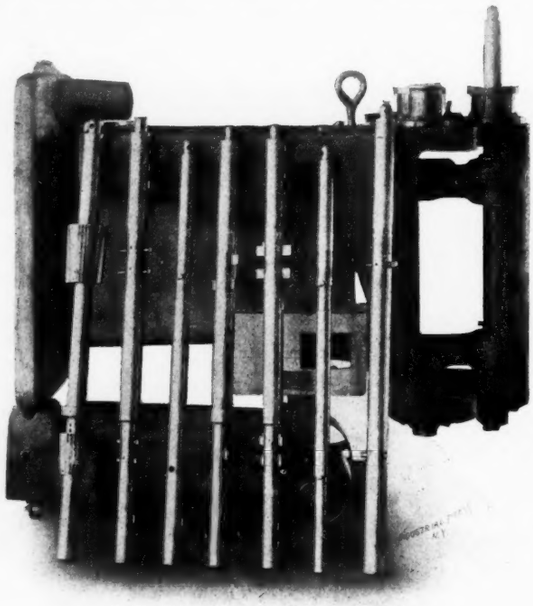


Fig. 18. Tools for Boring Main Spindle Bearing of Milling Machine.

# MACHINE SHOP EQUIPMENT.—8.

## MISCELLANEOUS EQUIPMENT.

OSCAR E. PERRIGO.

In this, the concluding article of this series, it is proposed to take up the smaller departments, special rooms, etc., in the same manner in which the subject has been treated in the previous articles and to give such a detailed description, in connection with the engravings, as to make the matter as complete as in any of the more important departments of the plant.

To many casual readers, or superficial observers, who may have read these articles it has doubtless appeared that very

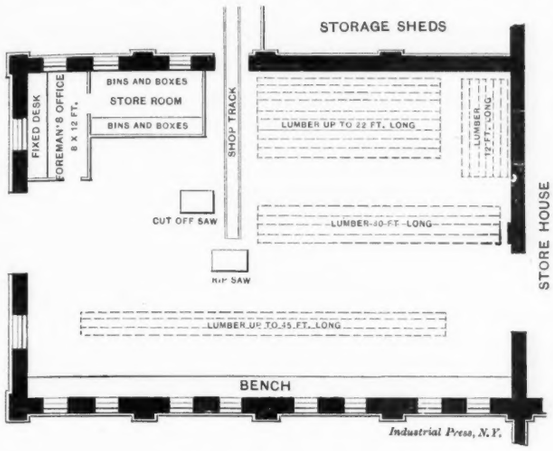



Fig. 1. The Carpenter Shop.

many of the matters considered have been treated with too great a regard for the smaller details and the minor points which, in their way of thinking, might be easily decided and disposed of at any time without much study as to just how this or that matter could be best handled, or this convenient accessory be best located, arranged or equipped. This ignoring of details, assuming them to be trifling matters, has often been the cause of much disappointment and useless expense, because what was, at the time, considered a trivial matter has, under perhaps somewhat unusual conditions, and sometimes under the most ordinary conditions, proven to be much more important than at first supposed, and given no end of trouble before being finally arranged in a thoroughly and practically satisfactory manner.

To practical men who have had experience in the designing and arranging of the various machine shop departments and accessories, or of those of a manufacturing plant, so as to afford the best accommodations and facilities for the class of business to be done there, at a reasonable economical expense; and to those who have had years of practice in superintending and managing the daily routine therein, it has doubtless occurred that there were many points in these articles that should have been much further elaborated, and whose details should have been gone into more thoroughly and explicitly. For these men know the annoyance, the disturbance of daily routine work, the inconvenience and the expense of alterations, changes and rearrangements that it has been their lot to encounter and their duty to remedy, in order to bring efficiency out of the ill-advised and unpractical plans and get everything running smoothly and satisfactorily.

The carpenter shop is located near the rear of the plant, between the machine shop proper and the forge shop, and adjoining the store house, or shipping room. Its internal arrangement is shown in Fig. 1. In this department should be stored the lumber and other packing material necessary for shipping, as well as for doing the miscellaneous carpenter work required about the plant. This material may be brought in on the yard cars by way of the track entering the side door; or, if received by the steam railroad cars, it may be brought in through the store house—a distance of only fifty feet. Lumber in long or short lengths will probably come in on the steam railroad cars, as it should be purchased in carload lots. It may be unloaded upon the yard cars at the rear gate and run directly into the carpenter shop. Convenient methods are shown, by dotted lines, in the engravings for locating the different lengths of lumber so as to render any length readily accessible without disturbing any other length. Ordinarily the lumber will be piled on the floor, but light, thin lumber, matched sheathing, etc., may be placed in racks overhead, where it will be more out of the way and safer from accidental injury. Box stuff cut to dimensions, as well as made-up boxes, may be similarly stored so as not to unnecessarily encumber the floor space.

In the outer corner of the shop is an inclosure serving as an office for the foreman. It is built of ⅞-inch matched sheathing to the height of 42 inches and above this height it is composed of a galvanized iron wire netting 4 feet wide and of 1 inch mesh, attached to a frame of 2 x 3 scantling, placed not over 5 feet apart, and forming also the framework supporting the sheathed portion below. The wire netting is tightly strained upon this and fastened with 16-ounce tacks, after which a face casing ½ inch thick and 3 inches wide is put on, along the top and bottom and vertically at each upright. A cap 1 inch thick and 3 inches wide is placed on top. At the top of the sheathing a 1 x 2 inch strip forms a cap, underneath which a ½ x 1 inch strip forms the finish. Doors may be conveniently made with side and top stiles 1 inch by 4½ inches, and the middle and bottom stiles 1 inch by 6 inches, all "halved together," glued and screwed, and covered with the wire netting, and finished with a facing strip ½ inch by 2 inches, mitered around each panel to cover the edges of the wire netting. These are very strong and quite light and answer the purpose admirably. The object of constructing inclosures in the shop in this manner is to obtain a reasonably secure partition, and at the same time one that will offer as little obstruction to the light as possible, and also permit as free observation of the various parts of the room, as well as of the inclosure itself. This method has been found in practice to be strong, durable and economical.

Along the side of this inclosure, next to the wall, is a fixed desk of proper height for a man standing, say, 41 inches. It should be 24 inches wide and incline to the front about 2

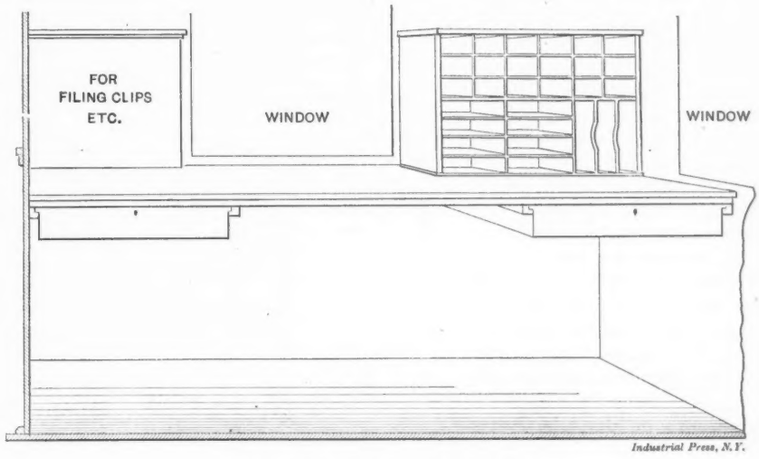



Fig. 2. Fixed Desk, Pigeon Holes, Etc.

inches in its width. Upon it, and in the corner between the two windows, should be placed a suitable pigeon-hole case, not over 24 inches high and 8½ inches deep. The top, bottom and sides are of ⅞ inch white pine and the partitions are of ½ inch stuff. This, with the desk, should be protected by two or three coats of shellac varnish. This case will be used for holding such blanks, slips, memoranda and similar papers as are in use. Proper space should also be provided for the necessary books relating to the carpenter work, boxing, skidding, shipping, and similar work. At the left-hand side, and

between the window and the partition, there should be fixed to the brick wall a board of the same height as the pigeonhole case for convenience in hanging filing clips and for similar purposes. Beneath the desk should be two drawers, about 5 inches deep, 24 inches from front to back and 30 inches wide, and provided with locks. Such an arrangement of desk, pigeon-hole case, drawers, etc., is shown in Fig. 2, which will give a general idea of its appearance and usefulness as well as of its economical construction.

The particular description here given of such fittings as these will apply to the design, arrangement and construction of similar cases, racks, shelves and other divided spaces necessary in many other parts of the plant, and we shall be well repaid for the time spent in carefully designing them to meet the special conditions and objects for which they are to be

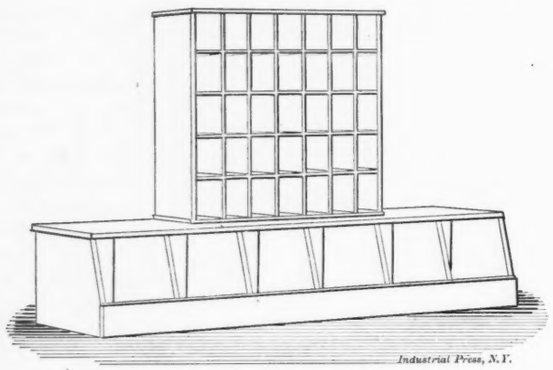


Fig. 3. Case for Lag Screws, Nails, Spikes, etc.

used, and shall often be enabled thereby to save quite a percentage of the time of the employees using them. They may be constructed by any good carpenter and will be in many respects the best as well as the most useful.

Adjoining the foreman's office and opening out of it is a similar inclosure, to be used as a store room for the carpenter shop and to hold such articles as may be much more conveniently kept here than in the principal store room, in the office portion of the plant, to be drawn in small quantities as needed. Against the wall is a case containing a row of bins for holding nails, spikes, etc. They are constructed of sufficient dimensions to hold a liberal supply of each size of nails and spikes, and the front board is made quite narrow, not over six inches high, to facilitate the removal of the contents. Above this row of bins is a case for lag screws, etc., containing thirty-five boxes, this being amply sufficient for all the different sizes usually needed. The width of this case is determined by the distance apart of the two windows between which it is located. At the left of this case, standing on top of the bins, and in front of the window, should be a small counter scale for weighing such articles as may be used or issued and are to be accounted for by weight. A perspective view of this case and the row of bins is given in Fig. 3.

On the opposite side of the store room is a somewhat similar case for holding nuts, washers, etc., in the bins, and having above it a case with forty-two compartments for machine bolts, carriage bolts, etc. A perspective view of this case is given in Fig. 4. Both of these cases are made of ⅞ inch pine and painted. The top of the bins is 24 inches from the floor. That shown in Fig. 3 is 6 feet high, but the one shown in Fig. 4 is limited to 5 feet so as not to unduly obstruct the light. The base of the bins is 18 inches wide. The depth of the upper cases is 8½ inches. In the construction of cases of this kind it is well to remember that they may be made of an ordinary quality of pine commonly called "box boards," planed on both sides. The horizontal boards or shelves are first put in, the ends resting on cleats screwed to the uprights at the ends of the case. The upright partitions are cut to the correct length on the cutting-off saw, set in place and "toe nailed" in front, and nailed through the back. All the shelves and upright partitions should be ⅛ inch narrower than the uprights at the ends, while the top should project ½ inch at the front and ends. The bins may be built in place, nailed to the floor, but it is sometimes desirable to have such fittings built separate and set in place when completed, so that they may be moved, in case it should be necessary to do so, without partially or wholly destroying them.

The location of the piles of lumber is indicated by dotted lines, and the capacity of the space is marked in each case. At the side of the yard track entering the carpenter shop is a cutting-off saw. This may be one with a sliding table, upon which the lumber to be cut is placed and moved toward the saw. But for rapid work a swinging saw, pivoted overhead, and quickly moved in an arc across the piece of lumber, is preferable for the ordinary rough work called for in the carpenter shop. Of course, such a saw must be carefully protected so that the careless use of it may not be dangerous to the workmen. Near the cutting-off saw is the rip saw, but located at right angles to it so that long lumber may be handled, and in order to increase this capacity it is placed between the two doors, thus permitting the handling of lumber of almost any length. A work bench occupies the entire length of the inner side of the shop, furnishing an ample space for five men at bench work. It is fitted with removable vises in order that long work may be handled if necessary. A door 10 feet wide leads into the yard and one of the same width into the store house. These should be sliding doors, the latter a properly protected fire door. A side door 4 feet wide gives entrance to the tram track from the yard. In the large, outer sliding door it is well to put a small swinging door, say 30 inches wide, for convenient use in winter, to avoid the necessity of sliding the large door for the passing in and out of the workmen.

The store house adjoins the carpenter shop, communicating with it by way of the 10-foot fire door just mentioned, and with the rear end of the machine shop by a 14-foot sliding door, also arranged as a fire door. The relative position, as well as the complete plan, is shown in the engraving in Fig. 5. A steam railroad track runs along the rear of the entire plant, and as closely as may be to the shipping doors of the store room. These are three in number, one of 12 feet, and the other two 8 feet in width. Six windows in this side and four in the end of the store house afford sufficient light for the usual purposes. The floor of the store room is raised above the floor of the machine shop to such a height that the top of the platforms of the cars running on the machine shop floor track will be the exact height of this floor. A portion of the floor of sufficient width to admit a shop platform car is cut out, as shown in Fig. 5. By this means machines may be placed on these cars by the traveling crane in the machine shop, run into the store room and unloaded on the

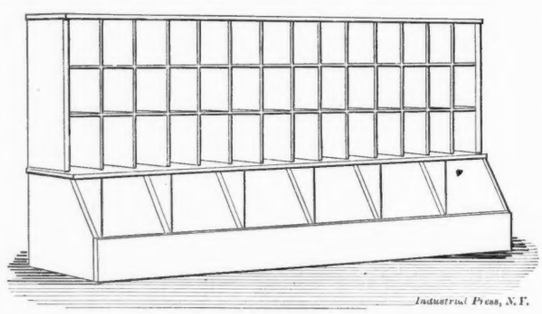


Fig. 4. Case for Machine Bolts, Nuts, Washers, etc.

floor at the exact level with the top of the car platform. From here they may be taken on rollers (if they are skidded) or on machine trucks, and put in their proper places on the store room floor. At each of the three shipping doors there should be an I-beam extending out over the railroad track, upon which is mounted a trolley hoist, preferably operated by compressed air or electricity. These I-beams should extend back, at least to the center of the store house, and better still, all the way across it. They may be connected by lateral I-beams, by curves, by turntables, etc., so that nearly all parts of the store house may be effectively covered. The lateral tram car tracks will prove a valuable adjunct to this system in moving machines from place to place on the store house floor.

In storing machines of various sizes in the store house while awaiting shipment it is frequently difficult to get at just the size of machine wanted without the trouble and expense of moving several others, for it is a common saying among shippers that "it is always the machine in the furthest corner that we want." In the dotted lines in the plan, Fig. 5, is laid out an arrangement of machines of a dozen different sizes, in such a manner that any size may be brought out for shipment without materially disturbing those of any other size. Of course this shows an arbitrary lot of sizes, but the plan here used, of reserving central aisles with cross aisles at proper intervals, is a plan which store room men and shippers will do well to familiarize themselves with and to adapt to their special needs by changing it to suit the particular class of machines with which they have to deal. In the case of small machines that may be stored on shelves, provision should be made for them by arranging shelving on the alcove plan, similar to that employed in storing patterns in the pattern storage room. In such cases such trucks as heretofore described in these articles may be advantageously used, the truck wheels being located so as to fit the regular shop track. Manufactured machines may then be handled with very little labor of loading and unloading, the use of the overhead trolley being brought into requisition whenever possible. Branches from them may be run over the centers of the alleys between the sections of shelving as may be necessary.

In all manufacturing establishments making machines in whose construction cast iron enters considerably, there is more or less painting required. The present demand is for very clean, smooth work, finished with some one of the various machine enamels. These enamels, so called, are to a great extent composed of a pigment mixed with some kind of varnish, usually of gum copal, thus forming the "air drying enamel," in contradistinction to the "baking enamel," so much used on bicycle parts and similar work. In the manufactory of the kind under consideration the machines will usually be of a size to render their removal to a special paint shop, and from thence, after painting, to a store house, a matter of considerable expense. They are, therefore, painted in the erecting departments, and the expense of providing a special painting department is avoided. Still there must be a safe and proper place for keeping paints, oils, and other painters' supplies and materials, and also to serve as a sort of shop for the painters. This kind of a room is shown in Fig. 6. It is located between the store house and the machine shop. The floor should be of brick, hard asphalt or concrete. On the side toward the store house are bins for holding dry colors. These should be raised three inches from the floor, and be constructed of ⅞ inch pine, similar in form to the bins in the carpenter shop store room, but with covers hinged at the top, for excluding dirt. On each side of the door is a bench 2 feet wide and 30 inches high, for convenience in mixing paints. Over each bench is a series of four shelves, 10 inches wide and placed respectively, 12, 10, 9, and 8 inches apart from the bench up. These will be convenient for storing small cans of ground paints, brushes, sandpaper and similar articles. Beneath the benches should be a shelf 16 inches from the floor, and each bench should be provided with a drawer 2 feet square and 8 inches deep, and furnished with a lock. The remainder of the space on the side toward the machine shop should be provided with a platform 16 inches from the floor, for holding barrels of oil, turpentine, etc., on their sides, and for barrels of such dry materials as it is not desirable to put in the bins.

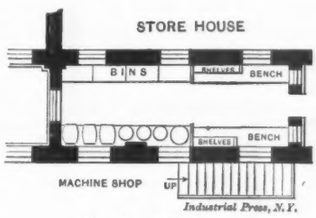


Fig. 6. Paint Room.

If considerable lampblack is used there should be a large galvanized receptacle, round or square, with a tightly fitting cover, for its storage, as there is always the danger of spontaneous combustion to be feared from it. Beneath the oil and the turpentine barrels there should be a drip pan of strong galvanized iron. The use of the lighter petroleum products such as gasoline should be avoided, if possible. If we are compelled to use them a separate store room should be built in the yard. It should have an iron roof, as a matter of ordinary protection. Any inflammable materials of this kind in use in the shops should be returned to it each night and taken out in the morning. The paint room should, of course, be always locked when none of the painters are working in it.

The wash rooms as well as the water closets are located in the rear portion of the power house, and upon each floor, the upper floor on a level with the floor of the machine shop galleries, this location being midway in the length of the machine shop proper, so within the most convenient distance from any point in the shop. There are two doors opening from the machine shop, one to be used as an entrance and the other as an exit door, to avoid the confusion that would otherwise take place if workmen going both in and out were to come in contact during the rush of the men in washing up and leaving the shops at quitting time. A series of lockers are located on each side of the room its entire length, and a double row located in the center of the room. These, with a few at either end, will give one hundred and twenty-eight lockers in the room. There are, of course, an equal number in both the upper and the lower rooms. In some of the departments, for instance in the small parts store room, and the assembling rooms,—perhaps in the grinding room, the carpenter shop, etc.,—the workmen may be provided with lockers in their work rooms, but the system can be better cared for by not breaking it up too much. Between the rows of lockers are the wash sinks, constructed after the plan shown in the article on iron foundry equipment, affording fresh, clean water to each man. The water used by the men for washing may be warmed in winter by passing it through a steam heating coil, and the difference in the temperature of the water no doubt would be much appreciated by the men.

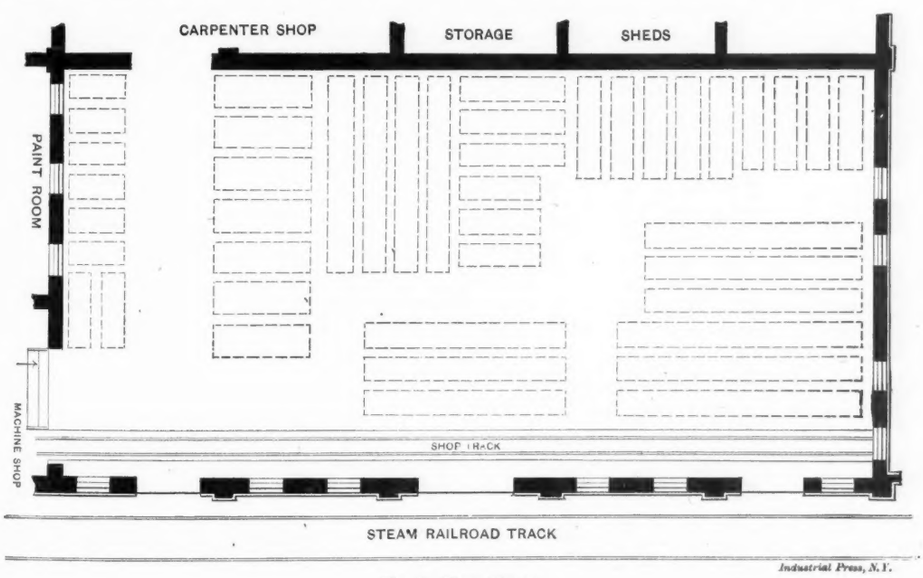


Fig. 5. Store House.

The windows along the outer wall of the wash room are

placed high enough in the wall to be above the lockers, which should be constructed of expanded metal, or its equivalent, but never of boards, or in any way to prevent the free circulation of air, and of sanitary cleanliness.

The water closet room opens from the wash rooms. Windows open from each side, and there is an additional one at the far end. Those on the sides are placed high enough to be out of the way of the water closets on one side and the urinals on the other. There are eighteen water closets and twenty-one urinals in the room. The urinals are divided by partitions 2 feet wide and 5 feet 8 inches high, and the water closets are 32 inches wide and project 4 feet from the wall. Each closet is provided with a light door having double swing, spring butts, and a sliding bolt on the inside. These doors should not reach the floor by about

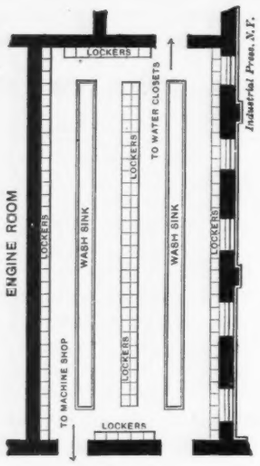



Fig. 7. Wash Room.

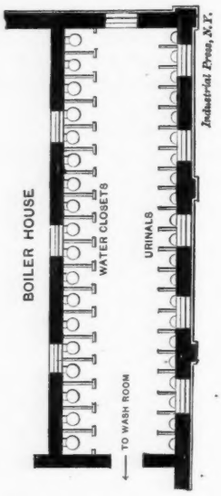



Fig. 8. Water Closets.

12 inches, and should extend to the top of the partition. The partitions should be 5 feet 8 inches high. All partitions of the water closets or urinals, if of wood, should be well painted with a heavy mineral paint, the last coat being of enamel, the preferable color being a steel gray, which is very hard and durable and will stand much washing. It will be better, of course, if these partitions are of metal, similarly painted They may be of cast iron $\frac{3}{8}$ of an inch thick, strengthened by suitable ribs. For the water closets wooden partitions will be preferable. The floor should be of some non-absorbent material with no seams or joints to retain offensive odors. A smoothly surfaced cement composition, such as is used for sidewalks, and commonly called "artificial stone" will be the best that can be put down at a reasonable expense. For the second story this may be laid, 2 inches thick, over a wooden floor composed of 3 x 4 inch scantling laid on edge. A similar floor will be suitable for the wash rooms, and much more economical, in the long run, than a wood floor, which will have to be renewed in a few years as it will decay from the constant wetting from the wash sinks. On the ground floor the cement surface may be prepared for by broken stone, etc., similar to the usual shop concrete floor, only not nearly so deep. All the piping for the water supply and for sewer connections should be in plain sight so as to be easily accessible when necessary to make repairs. The urinals should be automatically flushed with an ample supply of water at short intervals. The drainage pipes from the wash room should be utilized for flushing the sewer connections of the water closets and the urinals.

The water closets and urinals provided for the machine shop will be used also by the carpenter shop and the store house employees, but these employees may have lockers located in the carpenter shop, if desirable, and they will doubtless be better satisfied with such an arrangement. The wash rooms and water closet rooms should be in charge of an attendant whose duty it will be to see that everything is in proper working order and that sanitary regulations are strictly observed.

# TOOL MAKING.—5.

## TAPS.

E. R. MARKHAM.

Taps, if improperly made, are a source of great annoyance, and so few men understand how they should be made that in shops where taps and screw-thread dies are extensively used it is customary to keep one or more men exclusively on this class of work. These men, of course, become expert tap and die makers. Yet if a few important points are observed and a man possesses patience and a good supply of common sense, he need experience no difficulty when doing this class of work.

It must be well understood that unless the shape of the tooth or thread is the same on both tap and screw that are to go into the tapped hole, trouble will be experienced when the tap is used. I do not mean by this that if screws are made with threads improperly shaped we should make taps equally

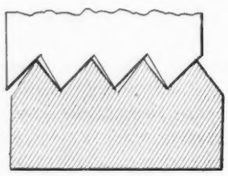


Fig. 1.

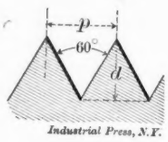



Fig. 2.

out of shape to match the screws. If taps and dies are properly made, and due care exercised when they are used, there will be but little trouble this way.

It should be borne in mind that the sides of the thread should bear on the sides of the thread in the tapped hole. Now if the sides of the threads on the tap are at one angle and those of the screw another angle, as shown in Fig. 1, the screw cannot run in and out of the tapped hole many times before it is loose.

Another thing to remember is that the lead of the tap and of the screw should be as nearly alike as it is possible to get them. While it is a fact that taps are very liable to alter their lead when hardened by the ordinary method, and that screws cut with a die do not, as a rule, have the same lead as the die they are cut with, yet the difference can be overcome in a great measure if the tap is hardened by the method known as "pack hardening," and the die properly made and hardened by the same method.

Having observed these precautions it is necessary to have die-holders made that will bring the die in correct alignment with the spindle of the machine being used. Trouble is experienced at times by screws having a "stretched" thread, i. e., the lead is long. On examination, the die may be found to be properly made, but further investigation may show that the heavy turret slide of the screw machine was dragged along by the die when cutting and this drag caused the thread to stretch, making the lead long. These points are given to aid the beginner when attempting to locate trouble resulting from a difference in the lead of a tap and of the screw that is used in connection with it. Notwithstanding the fact, however, that dies oftentimes stretch the thread cut with them, it is often considered advisable to cut with a die the threads on *small* taps which are not to be used in tapping *long* holes; and if care is exercised very satisfactory work will result.

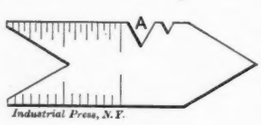



Fig. 3.

Various forms of dies are used in cutting threads on taps, formerly a jam die plate was used. The die used in this plate is made of two pieces of steel which have grooves at their ends to fit in ways in the plate. One part of the die can be moved back and forth to open and close it. It is pressed into the stock by means of a screw. Each time a cut is taken the desired length of the thread, the die is closed a little and another cut taken, which operation is continued until the thread is to the proper size. Or they may be left a few thousandths of an inch above size, and a sizing die run on to bring them to the correct size.

In shops where many taps of a size are made whose threads are cut with a die, it is customary to make dies of various sizes—the first die cutting a very shallow thread, and the finish die making it the required size. As many intermediate dies may be used as is deemed advisable; but for cutting the threads of taps ¼ inch diameter and under, three dies are generally considered sufficient. These may be held in one holder, or each die may be placed in a separate holder. If placed in one holder there is less liability of losing one of the set.

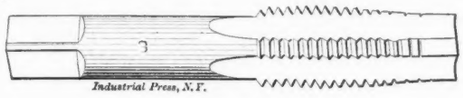



Fig. 4.

The finish die should be made adjustable, so that it may be adjusted to exact size, and also to compensate for any wear when it is used. The other dies comprising the set may be made solid, as they will not require any change of size. These dies and the methods of making will be described and illustrated in a future article on "Dies."

As previously stated, taps whose threads are cut with dies are liable to have the lead changed somewhat; but as the screws to be used in the holes tapped with them are made in a screw machine, and their threads cut with dies also, their lead is also apt to be long. But the length of hole tapped is generally not very long, so the change in lead does not materially affect the fit.

For the reader to clearly understand the term "lead" of a screw, as used in these articles, it has seemed wise to the writer to give here a brief explanation of the meaning of various terms pertaining to the number of threads in a given length of screw.

*Lead of a Screw.*—"Lead" is the term used to denote the distance a screw moves when turned once around. The "pitch" of the thread is the distance from the center of one thread to the center of the next thread, as shown in Fig. 2. The terms "lead" and "pitch" are often used to denote the same thing, and when applied to *single* threads this does not lead to confusion; but if applied to multiple-threaded screws, serious complications may result. For instance, a double-threaded screw whose "lead" is ½ inch—that is, where the screw must be turned twice around in order to advance it through one inch of space—when measured with a scale shows it to be ¼ inch "pitch." For a very complete explanation of the

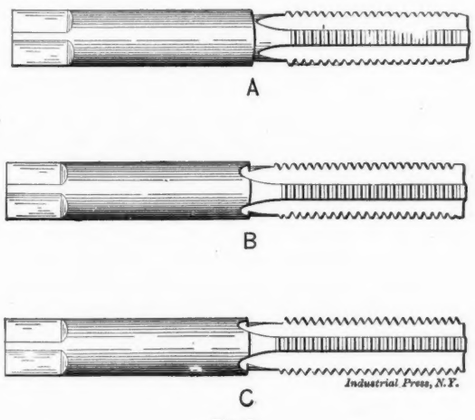



Fig. 5.

meaning of these terms we refer the reader to "A Hand Book for Apprenticed Machinists," by Mr. Oscar J. Beale.

When the threads of a tap are to be cut with a threading tool on an engine lathe it is essential that the tool be of exactly the proper shape; that is, the point must be ground to fit the 60-degree angle gage on one side of the center gage, as shown at *A*, Fig. 3. This is assuming that we are to cut either a V-thread or a United States Standard. Any other form of thread would necessitate shaping the tool to the angle called for.

As it is necessary to turn the blank to the proper dimensions before threading we will consider that before proceeding with instructions for threading. Stock—tool steel—should be selected enough larger than *finish* size to allow of removing all the decarbonized portion before it is to size. Care should be exercised when centering that the center holes are not made so large as to weaken the tap; neither should the countersinking be any deeper than is necessary. After removing the outer portion of the stock in the lathe, the piece may be annealed, provided it is ¾ inch diameter or larger. As to the most desirable method to use when annealing steel that is to be threaded for taps there is a difference of opinion among mechanics. Some claim that steel that is thoroughly annealed proves too soft, and tears in the process of threading and they recommend a "water anneal." Heat the steel to a *low* red, then hold in the dark until the red disappears, and the moment the red fades from view plunge in water. Soapy water or oil gives better satisfaction. Others claim best results if steel is heated red hot and buried in lime or ashes.

The writer always had good results when threading, if he annealed by heating to a *low* red, burying in a box with ashes, placing the tap between two pieces of board. The steel cooled

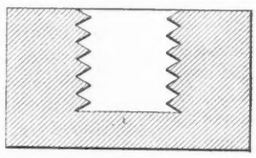


Fig. 6

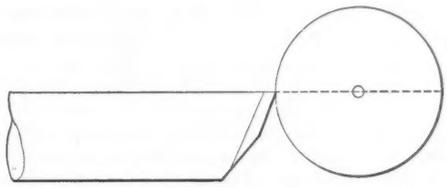


Fig. 7

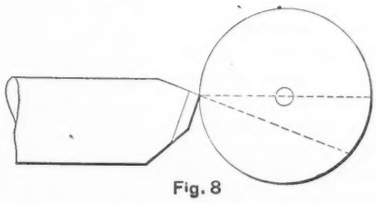


Fig. 8

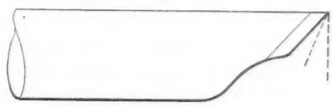



Fig. 9

below a red very quickly, but the boards which were charred from contact with the red-hot steel, kept the piece of steel hot for a long time. While a piece of steel must cool slowly when being annealed, to insure good results, it should not remain red-hot any longer than is necessary to insure its not being chilled, which would of course harden it. Yet it should cool very slowly from a point just below the red heat. Much of the steel that is annealed is subjected to heats that are too high, and this opens the grain and weakens the steel. As a result it crumbles off and tears when cut with a threading tool. So it is well to remember that steel exposed to a red heat for a long time grows weak and does not hold together properly when being cut with a threading tool.

If the tap is to be made of the form shown in Fig. 4 the portion marked *B* should first be turned to size, the squares milled, and the size stamped before the threaded portion is turned to size and threaded. When threading, set the point of the threading tool *exactly* at the height of the point of the lathe centers. If it is set above the center of the tap it will not cut well; and if it is set either *above* or *below* the center it will not produce a cut of the proper shape, that is, the angle of the tooth will be changed and it will not be of the proper shape.

For general shop use it is customary to make taps in sets of three, as shown in Fig. 5. These are known as "hand taps," and are operated by hand, using a tap wrench to turn them.

A set of hand taps consists of a "taper" tap, a "plug" tap and a "bottoming" tap. The former is used to start tapping a hole and is illustrated at *A*, Fig. 5. The plug tap is shown at *B*. This is used to tap a hole the threads of which must extend nearly to the bottom of the hole, as shown in Fig. 6. The form known as a bottoming tap is shown at *C*, Fig. 5, and is only used when it is necessary to extend the threads

to the *bottom* of the hole. However, it is not customary to tap holes in this manner if it can be avoided; so taps of this character are used but little. However, they are generally included in a set of jobbing taps, as they are needed occasionally.

Having ascertained that the threading tool is of the proper angle, and in good condition, it is placed in the toolpost, the point of the tool being on the exact height of the point of the lathe centers, as previously explained. To produce a cut the exact shape of the tool the top of the cutting portion of tool must be on a line with the center of the piece being cut, as shown in Fig. 7. Should the tool be ground on top and set as shown in Fig. 8, with the point at height of center of the piece being threaded, it would not produce a thread of the proper angle. It is also essential that there be sufficient clearance given the tool to prevent its "dragging" or poor work will result. But we should be careful not to give the tool too much clearance, in the manner shown in Fig. 9, or the cutting portion will not receive sufficient support and will break off when in use.

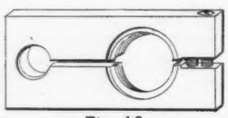
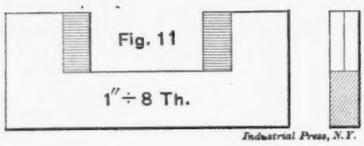


Fig. 10




The tool properly ground and set, we proceed to cut the threads. In the making of taps a *smooth* thread must be cut, and to do this light cuts must be taken, especially when the threading is nearly completed. While threading, use lard or sperm oil to lubricate the cutting edge of the tool.

For threading taps some toolmakers use a single-pointed tool, while others cut the thread nearly to size with a single-pointed tool, finishing it with a chaser of the proper pitch.

When gaging the threading for size in some shops they fit the thread to a size gage, one form of which is shown in Fig. 10; while in other shops the size is ascertained by means of a gage made of sheet steel, as shown in Fig. 11. The contact points of this gage fit between the threads and gage the size on the sides of the lands. When many taps of *different* sizes are made the necessary number of gages of this character would constitute quite a considerable item of expense, and it will be found more economical to use a micrometer caliper of the form shown in Fig. 12. The range of one of these micrometers is somewhat limited, but for frequent use they form the cheapest as well as the most accurate gage.

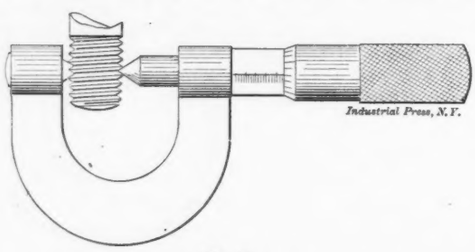



Fig. 12.

Most toolmakers when threading taps consider it good practice to give them a *slight* taper, making them .00025 inch smaller at the shank end. This prevents their binding when the cutting end becomes slightly worn, while the taper is not enough to affect the accuracy of the lead. After cutting the thread the cutting ends of the taper and plug taps may be shaped as shown in Fig. 4, the end of the taper tap being made the size of the bottom of the thread back for a short distance, as shown. The plug tap is beveled to an angle that will extend back two or three threads. Again, some toolmakers think it best practice to shape the ends of the taper and plug taps before cutting the threads. This does very well when a drawing, or a model tap is at hand, but unless such is the case it is more satisfactory to have this done after the threading.

To provide cutting edges it is necessary to make flutes in the tap. These are generally cut in the milling machine, although in shops where no such machine is available they are fluted on the lathe. The milling cutter is held on an arbor which in turn is held between the centers, and is driven by a dog. The work is secured in centers on the cross feed slide, or some other arrangement may be provided for holding it. For instance, a hole may be drilled in a block of cast iron or

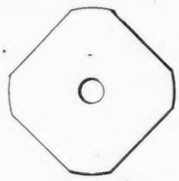


Fig. 13.

Fig. 14.

other material and this may be fastened to the slide. Taps are sometimes fluted in the shaper or planer, using a form tool of the proper shape. This method, however, is not to be advocated except as a makeshift, as the tap is very apt to be sprung, or the lead changed by the operation unless extreme care is observed.

Many changes have taken place during the past thirty years in the shape of the cutting edge. The writer remembers, when working as an apprentice, seeing taps which were made square, as shown in Fig. 13. The cutting edges were formed by the flat surfaces. The cutting edges not being properly shaped, there being very small space for chips, and the shape of tap being such as to cause the fine chips to be drawn back into the threads, it is needless to say the results were not as satisfactory as when a tap fluted as shown in Fig. 14 is used.

A milling machine cutter which is designed for cutting flutes in both taps and reamers is sometimes used to cut the

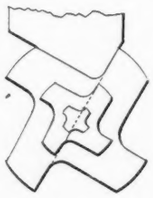


Fig. 15.

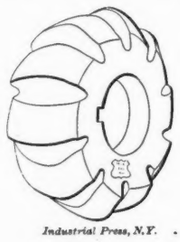



Fig. 16.

flutes of taps; but it really is not adapted to cutting either, as it does not give the proper shaped tooth to either tap or reamer. To be sure it provides a cutting edge and a groove, but in the case of the tap the groove is cut too deep and the land when subjected to strain is apt to spring out into the work, and catch, and if additional force is then applied to move it, the tap as a rule breaks. A tooth cut with a cutter of this form, together with a portion of a cutter, is shown in Fig. 15.

Fig. 16 illustrates a form of cutter adapted to grooving taps only. These cutters do not make as deep a groove in proportion as the tap and reamer cutters shown in Fig. 15. They are made by the Brown & Sharpe Mfg. Co. The list of the number of cutter, together with the diameter of tap it is made to cut, is given below:

| Number of Cutter. | Diameter of Tap. | Number of Cutter. | Diameter of Tap. |
|---|---|---|---|
| 1 | 0 to $\frac{1}{8}$″ | 5 | $\frac{11}{16}$″ to $\frac{7}{8}$″ |
| 2 | $\frac{5}{32}$″ " $\frac{1}{4}$″ | 6 | $\frac{15}{16}$″ " $1\frac{1}{4}$″ |
| 3 | $\frac{9}{32}$″ " $\frac{3}{8}$″ | 7 | $1\frac{5}{16}$″ " $1\frac{5}{8}$″ |
| 4 | $\frac{7}{16}$″ " $\frac{5}{8}$″ | 8 | $1\frac{11}{16}$″ " 2″ |

It is necessary to make the flutes of hand taps somewhat narrower than for machine taps. This is so as to leave the lands somewhat broader in order to steady the tap when in use; for a hand tap is forced into the hole by hand, the force being applied at the ends of tap wrench handle, while machine taps are held steadily in position by means of a chuck or collet.

When cutters like that shown in Fig. 16 are used the

groove should be milled to a depth that will make the land about one-quarter the diameter of the tap, provided the tap is given four flutes. Do not use a dull cutter when doing work of this character, for the work will spring, and in the case of taps the lead will be altered, as the tap will become elongated. The effect of using a dull cutter is similar to that produced by hammering a surface when pening it; it is stretched.

Clearance must be given the tap on the tapered portion at end so that it may cut. This is done with a file. Commencing at the heel of the tooth we carry the filing *to* the cutting edge, being careful not to remove any of this edge, for the tooth cut below the edge will do no work and the work will all be thrown on the remaining teeth. The strain in this case is unequal and the tap will not work as well as if each cutting edge does its share of the work. The exact amount of clearance cannot be given; by observing taps that work all right, one can acquaint himself with the proper amount.

In order that the workman may readily observe when he is approaching the cutting edge when filing for clearance, various methods are used. Some mechanics color the surface with Prussian blue; while others color it with the "copper solution" used in most shops for coloring surfaces where lines are to be drawn. To make this solution, dissolve in a bottle of water all the crystals of blue vitriol the water will take up; to this add a small amount of sulphuric acid—about one teaspoonful to three or four ounces of the solution. Another method consists in heating the tool over a slow fire until it assumes a distinct straw, or a blue color.

In shops where there is no emery wheel the face of the cutting edge and the back of the land are filed. The face must be filed in order to remove any burrs that may have been thrown into the spaces between the teeth when cutting the grooves, and to give the cutting edges keenness. The back of the land is filed to remove roughness incidental to cutting the grooves, so the chips will not cling to this surface.

Many mechanics consider it good practice to give all taps clearance between the teeth to relieve friction; but in the case of hand taps this does not appear necessary, especially if they are not larger than one inch diameter. However, if it is considered advisable to relieve taps in this manner, it may be accomplished by using a *sharp cornered* three cornered file. Commence at the heel of the tooth and file toward the cutting edge, not filing quite to the edge.

### Hardening Taps.

Probably no one tool used in machine shops gives more cause for worry when being hardened than a tap. And probably few mechanics realize the very large proportion of taps hardened that are thereby rendered unfit for use. As previously stated a screw should fit perfectly in a tapped hole for its *entire* length, yet if the tap stretches, or elongates, when hardened, the hole tapped with it must of necessity be of a *wrong* lead.

Taps are often unevenly heated and crooked when plunged in the bath, and in this condition they are unfit for use. But under ordinary circumstances they may be straightened by the method described for "straightening counterbores" in our last article.

As the teeth of taps are slender, and absorb heat much more rapidly than the balance of the piece, it is not safe to heat them in an open fire unless they are placed in a piece of gas pipe, or tube, which removes them from the direct action of the fire and the blast. The taps should be turned occasionally, in order that the heat may be uniform throughout the piece. When dipped in the bath the tap should be held in as nearly a vertical position as possible. The bath, which should be either clear water or brine, should not be very cold; lukewarm baths give best results when small pieces are hardened.

While careful heating and low heats will reduce the tendency of elongation, or contraction of pitch, it will not remove it altogether; and if we wish to maintain the original pitch and diametrical measurements we should resort to the method known as "pack hardening."

We will give a description of this method in our next article, in which the subject of taps will be concluded.

## SOME PRACTICAL POINTS IN MACHINE DESIGNS.

W. S. LEONARD.

The first requirement in a new machine is that it shall accomplish in a satisfactory manner the particular purpose for which it is designed; but collateral with this, and ever present in the mind of the experienced designer is that other problem of "constructional economy." Let A and B set out to design a machine for a certain work, and let it be understood that each is to rely on his own resources as to the means and devices to be employed, without knowing what the other is doing. Under these circumstances it is quite possible that B's machine may cost 25 to 50 per cent. more than A's, and yet not be any better for the purpose for which it was designed. Both machines may do the work equally well, but B's machine cannot be sold in competition with A's. B's machine is, therefore, a failure from a commercial standpoint.

If we inquire into the qualities to be striven for as affecting the constructional cost of a machine, we shall find that one of the prime considerations is simplicity. This means first, that the machine shall be easy to understand and operate. Some machines are necessarily so intricate as to require that a mechanic be sent from the factory to set them up and give instruction in operating them. But the experienced designer will endeavor to obviate such intricacy whenever it is possible to do so.

Simplicity means, secondly, that there is no unnecessary multiplication of parts. If two elements are used where one would do the same work, this would clearly be a violation of constructional economy. Every gear, every lever and every cam must be essential to the successful operation of the machine, and the designer's task is not complete as long as there is a reasonable doubt in this direction.

Constructional economy is also violated when a machine is unnecessarily difficult to assemble and to get apart for repairs. In building a new machine considerable experimenting is usually required before it is perfected. This necessitates taking out some of the parts a great many times to make alterations and adjustments. If a large portion of the machine must be disconnected to get at one part, too much time and labor is consumed. In the same way costly delays will sometimes be occasioned in making comparatively slight repairs or adjustments. If the designer would steer clear of these difficulties he must put himself in the places of the machinist and future operator, and, as it were, put together and take apart every device in the machine. In so doing he may find it expedient to make cap boxes in some places where there would otherwise have been solid bearings; and in certain lines of machines—printing presses for instance—he may make important modifications of the main frame work in order to make more easily accessible such parts as require frequent attention.

Constructional economy requires that all parts of the mechanism be of such shape as to admit of being machined with ordinary shop appliances. It would be an unpardonable error, for instance, to use some special form of toothed gear when further study would have demonstrated the feasibility of using the standard shape. So, also, all kinds of irregular and untried devices would be objectionable when mechanism known to be right could be made to serve the same purpose. In looking over the models at the patent office one will sometimes find machines which are, indeed, "fearfully and wonderfully made." But many of these machines never got beyond the model stage, and doubtless some that did come into practical use were remodeled to such an extent as to scarcely resemble the original.

Another matter which adds to constructional expense is the unnecessary multiplication of sizes. Take, for instance, a shaft or spindle three feet long and 4 inches largest diameter. If practicable to make this shaft with four shoulders and diameters it would be bad designing to make it with six. It takes time to turn and gage these extra diameters and lengths between shoulders, and if this be repeated on a number of shafts in a machine the additional expense is considerable. In designing such work, or, indeed, any work

where standard gages could be used, it is important not only to avoid multiplying sizes, but also to have in mind the sizes in which gages are made, and as far as practicable conform to these sizes.

### Taper Fits versus "Straight" Fits.

Speaking generally, designers use taper fits only in special cases; but occasionally we meet one who insists that "the taper fit is the only fit." A gentleman of this persuasion was for a short time superintendent for a concern with which the writer was employed as head draftsman. He began his work by having all drawings for gears, etc., made for taper fits, and held his position just long enough to get everybody in the shop into some other kind of fits. The draftsman was compelled to go against his judgment, the shop was compelled to make a line of taper reamers and taper gages, and it required greater skill in the shop to do the work. If there are two gears on taper fits on a shaft, and the workman makes these tapers in such a way that the gears are, say ⅛ inch too close together, that shaft is spoiled. On straight fits the gears could be moved apart without materially disturbing the fit. As intimated, the superintendent was with the company but a short time. No sooner had he left than the chief draftsman went back to straight fits, when the expensive gages and taper reamers were laid away to rest.

The experienced designer is careful to provide against cooling strains in castings. Brackets, pulleys and all kinds of frame work are likely to have light ribs or arms joined to heavy bosses. In such places strength as well as looks demands that the light member be connected to the heavy member by liberal fillets. If the fillets are omitted the unequal cooling at these places may cause serious stresses in the casting. By uncovering the heavy parts first the molder may partly overcome this difficulty, but the designer should not leave too much to the molder. Important castings have been known to break by a slight jar while being carted from foundry to machine shop.

Tool strains must also be looked after. Take, for example, an 18-inch gear of 16 pitch and having six arms, and assume that it is to run at a high speed with but slight pressure—merely to transmit motion. Under such circumstances an inexperienced designer might make the rim so frail as to necessitate running the milling cutter through the teeth twice to keep from springing the gear by one heavy cut. Otherwise the gear would not be round, and at a high speed it would be noisy. Sufficient metal to support the rim against the pressure of the milling cutter would be much cheaper than passing the cutter through the second time. For similar reasons a long rod or screw would sometimes be made heavier than the operating duty might require.

The range and capacity of the turret lathe has been greatly extended within the last 20 years; and it is generally understood that many kinds of short steel pieces can be machined much cheaper in the turret lathe than in the common engine lathe. Such work is usually turned from the bar without any forging, and to facilitate this, any shoulders or collars that may be required on such work should be made with minimum diameters. This saves not only time in machining, but also saves material. The draftsman who fails to appreciate the economy of the turret machine, and of designing with special reference to turret methods is certainly not up-to-date in his profession. Within the last 10 or 15 years a modified design of turret machine has come into use. This tool is adapted to a large class of work which may be termed "chuck work"—gear blanks, small pulleys, etc. The several internal diameters of a stepped cone pulley may, by the use of a suitable cutter bar and cutters, be turned in one operation in such a machine.

Constructional economy may often be materially enhanced by designing machine parts with reference to convenient adjustment of same on lathe, planer or other tool. A casting may be of such shape as to be almost unmanageable in the lathe chuck, when the addition of four small lugs to receive the thrust of chuck jaws would entirely obviate the difficulty. This principle is also often applied in connection with planer work, and in various other ways; and in most cases the lugs or projections are in no way objectionable in the finished detail. If they are objectionable it is but little trouble to cut them off. It is sometimes practicable to make slight modifications which greatly facilitate machining a casting, and which are not detrimental to the machine of which the casting is a part. In the case of a printing press, or other machine having two side-frame castings. It it desirable to have all planing surfaces on the inner side of each casting in the same plane. In some cases the planing bosses on the outer sides also may be in even planes. It is very easy to bed such a casting on the planer table, and when planed the two castings may be bolted together and opposite holes accurately and quickly drilled and reamed. It will be obvious to the machinist that these castings would be much more difficult to machine if made with bosses and planing surfaces of varying heights. When extra long bearings, which project beyond the common planing line, are needed, it is frequently expedient to use flanged bushings. The bushings are held in holes bored in the frame, by bolts passing through the flanges. The writer has designed such bushings large enough to allow a shaft with several small gears to be passed through the hole in side frame castings without removing the gears. With such a design the bushing has one of the advantages of the cap-box. It also possesses one advantage that is lacking in the cap-box; that is, it enables the operator to duplicate a worn-out bearing very cheaply, and without disturbing the original alignment of the shaft.

The importance of providing the raised surfaces above-mentioned, and the height of the surfaces above the rough line of the frame, are not always understood by the beginner. For the information of the latter it may be explained that it is much cheaper to machine the limited area where details are bolted on than to machine the broad surface of the frame. As to the amount, the minimum height could be taken as ⅛-inch for a frame four feet long and less, with an addition of 1-16-inch for every additional four feet. This does not include the stock to be planed off. Generally the patternmaker can be trusted to provide the proper stock for machining; but an allowance of ⅛-inch for the first four feet of length, and 1-32-inch for each additional four feet would be about right in most lines of work. The rough height would then be ¼-inch for 4 feet, 11-32-inch for 8 feet, and 7-16-inch for 12 feet. In the proportions here given it is assumed that the width of the frame is not greater than the length, or that the allowances apply to the greatest dimensions. The reasons for allowing more on a long frame than a short one are that the pattern, or mold, or both, are more likely to be warped or otherwise put out of shape in the case of the longer frame. It may be well to repeat that the finished heights of the planed surfaces or bosses are the minimum as given above, and nothing is said against making them as much higher as circumstances may require.

Because of irregularities in shrinkage, and slight errors in the pattern, bosses usually need to be made from 1-6 to ¼ inch larger in diameter than the corresponding boss or hub of the adjoining detail. Here again we make greater allowance on long frames than short ones. The eccentricity of the bosses may be corrected by chipping or by "trueing up" with cutter bar and cutter in the drill press. Warpage and other irregularities have to be taken into account, also, in making allowance for the clearance of moving parts in the machine. This is a very simple proposition, but it is nevertheless often overlooked. The same habit of mind which leads to this error will cause the designer to locate bolt holes so close to the web in a frame, as to necessitate chipping the casting to make room for the bolt head and wrench. The drawing looks all right, but one can never depend upon rough frame lines being exactly like the drawing. Neither can cored holes be expected to be like the drawing. The back gear quill of a lathe is commonly recessed out in the center, leaving a bearing at each end for the eccentric shaft. This is done to save the needless expense of boring the whole length. But if some allowance is not made for the deflection or displacement of the core, the machine shop may have to contend with the very difficult operation of machining the recess as well as the bearings on the two ends. This would be more expensive than if the core had been made of one diameter the whole length.

In a job of this character the recess core should be at least ¼ inch larger than the shaft—⅜ inch would be safer.

In planning a series of machines much needless expense may be avoided by designing many of the details with reference to their use in two or more machines of the series. While this expedient tends to economy in all the processes of manufacture, the greatest saving will generally be in the machine shop. Here fewer special fixtures, jigs, gages, etc., will be required, and larger quantities of the duplicate pieces may be made without overstocking. Experience and good judgment, however, are of great importance in this connection. In order to make certain parts answer for a small and large machine, we sometimes have to make them somewhat heavier than necessary for the small machine in order to make them sufficiently strong for the larger one; and if this matter be carried too far we will have badly-proportioned machines. In large frame-work we may often make one pattern answer for two machines by merely changing such loose parts as bosses, lugs, etc.

The question of machine design involves so many practical considerations that in writing an article of this character it is difficult to determine where to leave off. It may be well to conclude, however, with a bit of advice to the young designer and technical graduate, for whom this article is more particularly intended. However optimistic you may feel respecting a new design, do not be extravagant in estimating the performance of the machine. Every new machine is to some extent an experiment. It may accomplish all you predict; it is more likely to do less. Some very trifling and unlooked-for causes may sometimes seriously interfere with the production of a machine. A very fine printing press, built by an Eastern concern, did an excellent quality of work; but the quantity was disappointing, because the mechanism would not, after all the exacting requirements as to printing were done, deliver the sheets in a uniform manner. About one sheet in 20 or 30 would crumple in such a way as to disarrange the following sheets until the press was stopped, and the disordered sheets removed. The difficulty was entirely overcome by running the press at a slower speed, but the output was less than estimated. In other cases, machines which were satisfactory as to the quality and quantity of the output have been condemned because of their being too noisy in operation. Expensive alterations are sometimes required to remedy evils which, to the inexperienced, seem of slight importance, and which are very easily overlooked in designing a new machine.

* * *

## A. S. M. E. MEETING IN CHICAGO, MAY 31.

The Chicago meeting of the American Society of Mechanical Engineers is to be a joint meeting of the American and British societies of Mechanical Engineers, and will begin on May 31. The purpose of many of the visiting members will be not only the meeting and the Exposition in St. Louis, but the privilege which the Americans will give them for a study of our establishments and methods. The Council of our Society (American) desires to facilitate and further the purpose of the visiting engineers in each city in which their interests may center. It is proposed that during the continuance of the British visit, in the months of May and June, there should be organized in each city a Bureau of Information in the office of one of the A. S. M. E. members in that city.

The Secretary of the American Society will accredit the visiting British engineer to the local office, by a letter, and in this local office the visitor shall be instructed as to the establishments he wants to see, how to reach them and for whom he is to ask and present his credentials. It is believed that by this system of special centers, with definite and exact knowledge in each, the purpose of the visitors can be best secured, and with the least amount of apparatus and equipment to bring about the result.

The American members in each city are requested, therefore, to consult with the other members, by telephoning or otherwise, for selecting the committee and securing the address of its executive, who shall be willing to serve the convenience of the visiting members and the purpose of the Society in effective hospitality. This request does not apply to members resident in New York City, Chicago, or St. Louis, but to every other city outside of the three mentioned.

It is expected that no expense should be incurred in the conduct of this plan, but only the rendering of personal service in the way of advice.

If the members will co-operate by communicating with each other as soon as possible, and settling on their committee and the central office to which the Secretary may direct visitors, the purpose of the plan will be most effectively carried out. The visiting members from England should be early advised as to details of this plan, and before leaving home.

The Secretary's office will be asked to guide the visitors to the places in the United States where they can best see the processes in which they are interested. Our members are requested to indicate to the Secretary, therefore, those industrial establishments in their cities where such matters may be studied and where visitors will be welcomed. The Secretary's office seeks to extend its own knowledge by getting the advice of all the members. It will be convenient for this purpose if the headquarters of the Society in New York can be supplied with the catalogues of the various concerns represented in the membership, and of interest in their city or town outside of the membership—such trade catalogues as will be serviceable to the British visitors that they may be made available to them by indexing and in other ways.

It will also be of great use to the visitors if the Secretary can give to them a suggestion of a hotel in each American city at which they will feel at home.

A Committee on Meetings has been appointed to secure papers of importance and interest for publication in the transactions of the Society and to be read at its meetings. A blank has been prepared showing the line of thought of the committee, the topics being grouped under various headings. This blank will be supplied to any of the members who have something to contribute or who can suggest the name of a possible contributor on some timely subject. Address all communications to Secretary A. S. M. E., 12 W. 31st St., New York.

* * *

### UNIVERSAL TECHNICAL DICTIONARY.

The Technolexicon of the Society of German Engineers, or universal technical dictionary for translation purposes, in English, German, and French, the compilation of which was begun in 1901 under the auspices of the Society of German Engineers, has received help up to the present time from 363 technical societies at home and abroad; 51 of these are English, American, South African, etc., 274 German, Austrian, and German-Swiss, and 38 French, Belgian, and French-Swiss societies. Of firms and individual collaborators 2,573 have promised contributions. The excerption of texts in one, two or three languages (handbooks, pamphlets, business letters, catalogues, price lists, etc.) and of the existing dictionaries has yielded 1,920,000 word-cards so far. To these will be added within the next two years the hundred thousands of word-cards that will form the result of the original contributions—those already sent in and those still expected—of the 2,573 collaborators at home and abroad, when the editors in Berlin have finished them for the press. Specially made handy note-books had been placed at the disposal of the collaborators to write their collections in, of which 317 have come in filled so far. All the outstanding contributions will be called in by Easter of this year, 1904. The collaborators are therefore requested to close their note-books or other contributions—unless a later term has been especially arranged with the Editor-in-Chief—by the end of March and to forward them to the address given below. As the printing of the Technolexicon is to begin in the middle of 1906, delayed contributions can be made use of in exceptional cases only, up to that time. Further information can be had by addressing: Technolexicon, Dr. Hubert Jansen, Berlin (N.W. 7), Dorotheenstrasse 49.

* * *

The temperature of the flame of a kerosene lamp is about 2,800 degrees F.; of an arc lamp, 5,400 degrees; and of the sun 9,000 degrees (estimated).

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# MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

APRIL, 1904.

NET CIRCULATION FOR MARCH, 1904,—23,855 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

## REGARDING THE INDICATOR.

In the recent issue of a contemporary were shown two outside-spring steam engine indicators that have been placed on the market by prominent American firms, both instruments having the usual coiled springs, but which are placed above the cylinder on an extension of the piston rod. The added length of the piston rod and general change in design necessitated a proportional increase in the weight of the reciprocating parts, and the interesting thing about the indicators is that their designers adopted exactly opposite methods to compensate for this increase in weight. The usual area of an indicator piston is half a square inch, and the stiffness of spring corresponds to the total steam pressure upon a piston of this area. In one of the new indicators, however, the area of the piston is *increased* to one square inch, in order to give a greater force of steam to operate the heavier parts, and the spring is made proportionally heavier; while in the other the area of piston is *reduced* to one-quarter inch, enabling the piston and other parts to be proportionally lighter, their total weight being, probably, about the same as in the old style indicator with its half-inch piston. Now both systems of construction cannot be right, although both are probably right enough when it comes to practice. One can pay his money and take his choice. This is a good illustration of the tendency of men working along independent lines to go ahead in opposite directions, and it behooves us to consider, when we are positive we are right and the other fellow wrong, that he may be as nearly right as we are, after all.

In regard to outside-spring indicators, wherein are they better or more accurate than the old style, with the spring located within the cylinder? It is easier to change the spring, no doubt, when it is situated outside the cylinder, which is convenient; but does the outside spring produce as accurate a diagram, after all? The inclosed indicator spring does not come in contact with steam at a temperature much, if any, greater than that corresponding to atmospheric pressure, or 212 degrees. Prof. Carpenter, in an investigation of the subject, came to the conclusion that the steam escaping past the indicator piston under atmospheric pressure might be superheated a slight amount, and places the temperature of the steam surrounding the spring at 220 degrees, which temperature would be very nearly constant under all conditions. When Mr. Chas. T. Porter began to manufacture indicators, he found that a spring at 212 degrees was one pound in 40 weaker than when at the normal temperature of a room, or that a raise of about 150 degrees would affect the spring one pound in 40. This being the case, the difference in temperatures of engine rooms, which might easily be 40 or 50 degrees, would have an unfavorable effect on the outside-spring indicator, while the inside-spring indicator would always be subjected to very nearly the same degree of heat, which, if properly allowed for in calibrating the spring, ought not to produce variable results.

When the indicator was introduced by Watt, and a few favored ones discovered its great value, the most secretive methods were adopted by those who had been let into its secret. It is related that an engineer once visited an old water works plant at Moscow, Russia, where a Boulton and Watt engine was in operation, and in the examination of the relic he found near the end of the walking beam what proved to be a movable cover, made in such a manner that its presence could not easily be detected. After cover was removed, however, a recess was disclosed in which was concealed an ancient Watt indicator, showing that it had been looked upon as sort of a trade secret. Undoubtedly, however, the indicator has since filled a greater place in the education of mechanical men than any other instrument of the past century. It has been the aim of every stationary engineer to own one and study the lessons of the indicator diagram. We realize with somewhat of a pang, therefore, that wherever the steam turbine is now installed the indicator must be put upon the shelf as a back number, for there is no such thing as the indicated horse power of a steam turbine. It is not needed to understand the action of the turbine, which requires instead the study of the flow of steam through the intricate passages of the wheel and the losses from leakage and friction —questions that are more complex and less easy of solution than most problems connected with the reciprocating steam engine.

* * *

### WHERE INTERCHANGEABILITY PAYS.

If we can believe one item of the meager war news received from the Far East, the reason the Russian forts at Vladivostock did not return the fire of the Japanese war vessels during the attack of March 6, was that the shells supplied by the Russian war department were two millimeters (0.078 inch) too large for the bore of the Vladivostock guns. It is difficult to understand why guns of large caliber were built with so little difference in bore and the natural inference is that the difference is one due to slipshop methods of measurement and keeping records. It matters little whether measures are expressed in inches, millimeters or duimes, but it does matter greatly if 10 duimes at St. Petersburg mean something else at Vladivostock.

We do not need to go abroad, however, to discover the evils of many standards or rather of no standards at all. The recent big fires in Baltimore and Rochester called renewed attention to the great diversity of hose couplings and hydrant connections. Almost every large city is a law unto itself in this respect, each having a standard of its own, and in the event of a big fire that requires outside assistance there is much trouble, if not actual impossibility of making connections between the fire engines and hydrants. It seems that a national hydrant nozzle should be adopted by all American cities and towns—the matter of hose connections is not so vital, but this matter should also receive attention. Speaking of hydrant nozzles being made standard, why should not engine lathes of the same swing be made with the same size nose and thread so that all chucks and faceplates for one size of lathe will be interchangeable? This is the condition existing in one New York machine shop that we know of and the convenience of the system is well worth the trouble of making all the lathe noses to a common standard. When new lathes are ordered for this shop the size of the spindle nose is specified in the order.

## MACHINE SHOP EQUIPMENT.

The series of articles by Mr. Oscar E. Perrigo, upon machine shop equipment, closes with this number. We believe this has proven to be one of the most interesting and valuable series published, inasmuch as Mr. Perrigo has described in detail the various devices that enter into the equipment of a machine plant and has based his descriptions not only upon the result of his own experience, but upon information secured through extended investigation. One who has had a plant to equip realizes how much time is required to decide upon some of the apparently trivial features, and these have not been overlooked, as has so often been done by more superficial writers.

As supplementary to his closing article, Mr. Perrigo writes that the series should hardly close without referring briefly to facilities for providing lunches for the employees. "In many of the modern and up-to-date manufacturing plants," he says, "there has been considerable effort made, and considerable expense incurred, to provide for the employees such useful accommodations as dining rooms, cook kitchens and the necessary accessories which go to make such arrangements complete and serviceable.

"There have also been provided assembly, lecture and reading rooms, and similar conveniences, not directly connected with the strictly manufacturing operations. All these matters are very commendable, and show not only a proper spirit of liberality on the part of the owners of the plant, but a deep interest in the individual welfare and comfort of the employees, as well as in their educational and intellectual advancement.

"In the design, construction and equipment of a plant, however, we have endeavored to confine everything as closely as possible to the actual necessities of manufacturing facilities, and while endeavoring to adopt all proper conveniences for successful manufacturing, it has been the aim to avoid the question of such conveniences as might be termed luxuries, purely from reasons of economy. These facilities and improvements will follow quite naturally as the plant grows older, without special suggestions to that end, and ofttimes quite as frequently as the conservative owners of the plant will want to pay for them."

* * *

## NEW VENTURES OF THE ALLIS-CHALMERS COMPANY.

When the General Electric Company definitely decided to enter the steam turbine field, it was to be expected that the Allis-Chalmers Co. with their new West Milwaukee shops, would make some counter move. The Westinghouse companies were preparing to supply generating units complete with both the electric generator and the steam engine or turbine for driving it. The Allis Co. therefore must look for a large part of their business in the supply of reciprocating engines for driving apparatus built by the General Electric Co.; and when the latter decided to advocate the turbine, and built a large plant for building much of the steam machinery that they would require, the Allis-Chalmers Co. were forced to take such action as would place them on an entirely independent basis.

It has previously been announced that the Allis-Chalmers Co. had acquired the American patents, and were the sole licensees for the western hemisphere, of the Nurnberg gas engines, built by the Nurnberg Machinery Co., Nurnberg, Germany, which they were prepared to supply in sizes up to 6,000 horse power. They have also become the licensees of the hydraulic machinery of Escher-Wyss & Co., Zurich, Switzerland, who have designed upward of 85,000 horse power installed at the Niagara Falls plant of the Cataract Construction Co. While these two acquisitions will probably greatly increase the production of power-generating apparatus by the Allis-Chalmers Co., the move they have resorted to to make themselves independent of the two electrical companies is even more important. They have become associated with, and form part of, the Turbine Advisory Syndicate of England, comprising the Yarrow Shipbuilding Co., the Tweedie (Vulcan) Shipbuilding Co., Willans & Robinson, and Mr. Fullager, formerly chief engineer of the Parsons Steam Turbine Co., of England. They will shortly prepare to build steam turbines of the horizontal Parsons type, in units up to 10,000 K. W. Mr. Robert A. McKee, formerly an engineer with the Westinghouse Machine Co., is the mechanical engineer of the steam turbine department of the Allis-Chalmers Co. Arrangements have also been made for the manufacture of electrical machinery and this department will be in charge of Mr. John F. Kelly, formerly of the Stanley Electric Co., and Mr. Wm. Stanley, Jr., who will act in a consulting capacity.

These developments, which have come in such rapid succession, bid fair to be more far-reaching in their results than any event in their field since the Westinghouse Machine Co. began to manufacture prime movers for large generating plants a few years ago. It was estimated that it would take the Allis-Chalmers Co. something like two years to secure the equipment, designs, and patterns for a line of heavy electrical machinery, but there has been another occurrence in the rapid succession of events. It appears that the Bullock Electric Mfg. Co., of Cincinnati, which is a New Jersey corporation, has been leased by a new Bullock Company, organized under the laws of Ohio. The new corporation is one in which the Allis-Chalmers Co. are financially interested as principal owners. Inasmuch as the Bullock Electric Mfg. Co. have added to their standard line of direct-current motors and generators rotary converters and some of the largest types of alternating-current machinery, the Allis-Chalmers Co. are therefore able to fill orders at once ranging throughout the entire field of electrical machinery, and are in a position to supply reciprocating steam engines, gas engines, and steam or water turbines for prime movers.

In this connection it is interesting to note that when Mr. Reynolds, formerly chief engineer of the Reynolds-Corliss Engine Co., first came into engineering control of the old Milwaukee works, he predicted direct-connected units such as are now being used, and advocated the manufacture of electrical and steam apparatus by that company, as soon as the state of the art should be such that this could be accomplished. We thus see how the dreams of this famous engineer have come to pass, but on a more magnificent scale than he would have dared to predict.

* * *

### OTHER TURBINE DEVELOPMENTS.

Another interesting development is the formation of the United Steam Turbine Co., of Berlin, for the exploitation in Austria-Hungary, Russia, and several of the smaller European countries, of important American and foreign patents. The American patents are those controlled by the General Electric Co.'s interests in this country, and those of the Allegemeine Elektricitats Gesellschaft, of Berlin, Germany, and of the Union Electric Co., also of Berlin. The new United Steam Turbine Co. control the patents on the Riedler-Stumpf steam turbine, illustrated in the February number of MACHINERY, as well as the Curtis steam turbine patents—which places them in a position to exploit these two types of turbines. Furthermore, there has been a transaction between the Allegemeine Elektricitats Gesellschaft and Brown, Boveri & Co., Winterthur, Switzerland, by which the turbine as developed by the former company will be introduced into a wider field in other sections of Europe. In this country it is generally known that the Hooven, Owens & Rentschler Co., Hamilton, O., manufacturers of the Hamilton-Corliss engine, are at work on a steam turbine of large size which, if successful, will be exhibited at St. Louis. This turbine is understood to be similar in principle to the Rateau though, as far as we can learn, it is not manufactured under an arrangement made with Messrs. Sautter, Harle & Co., of Paris, France, the original manufacturers of this type.

* * *

A cement that makes water-tight joints is made of sulphur and sand mixed in the proportions of 1 and 1 or 5 to 7, sand being the larger constituent. The mixture melts at 250 degrees F. and is poured like lead. It is much stronger than pure sulphur, the strength of pure sulphur being only about 100 pounds per square inch, while the sulphur-sand mixture has a tensile strength of about 650 pounds per square inch. The *Engineering Record* says it is unaffected by frost or heat up to the melting point, or by acid and alkaline liquors.

# ENGINEERING REVIEW.

## CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

After thirty years of intermittent labor the south bore of the Hudson River tunnel, connecting Fourteenth St., Jersey City, with Morton St., New York, was completed March 11—that is, the last headings were coupled but there remains much work to do on the approaches. The north bore is still to be completed and it is expected that both bores will be in working order about April, 1905.

Mr. James P. Lee, the inventor of the Lee magazine rifle, known variously as the Lee-Enfield, Lee-Metford, etc., died recently at New Haven, Conn., at the age of 73. Mr. Lee's inventions were favorably received in England, but he failed to get them adopted by the United States. Mr. Lee, we believe, was the first to use the detachable magazine in which the cartridges are assembled one above the other with a spring beneath all to feed them upward into the breech.

A so-called aluminum soldering process for uniting aluminum to steel or iron was recently described in a German technical publication. The iron pieces are first electroplated with copper and then aluminum in the melted state is poured on. The iron piece, of course, is in a suitable mold and the shape of the aluminum boss is determined by the shape of its portion of the mold. In this manner cast iron or cast steel cylinders may be made with aluminum bosses or other parts perfectly united since the aluminum has a great affinity for the copper when in the molten state at a cherry red temperature.

According to the accounts the experiments on heat transference through boiler plates, which were conducted in Germany some time ago, have demonstrated that the value of stirring or circulating the water increases with the intensity of the agitation, the increase of efficiency being small, of course, as the agitation becomes brisker, but no limit was reached beyond which there was no increase in the heat conductivity. It is suggested that one reason for the superior steaming efficiency of the locomotive boiler is the mechanical agitation to which the water is subjected, since it probably helps to detach the steam bubbles from the surfaces of the tubes and plates.

When the American engineers were building an electric power station in the Mysore territory in southern India they found that something was wrong with the lubrication of the machinery. The oil disappeared. They discovered that a Hindu must, by his religion, take a periodical bath in oil. To him oil is oil. The workmen had drained the bearings for bathing purposes. How to stop the thieving was a puzzling problem until some one solved it. The Hindu does not eat meat, and he will not touch anything that has blood in it. Two or three animals were killed, therefore, and blood was dripped into the bearings. There was no more stealing of oil, however many other things were stolen.—*The World's Work.*

In an address on electrically-driven shops, delivered by Mr. R. L. Warner before the Electrical Engineering Society of Worcester Polytechnic Institute, November 20, 1903, mention was made of the great value of the traveling bridge crane; the great manufacturing plants of the present time would be practically impossible without it. In the same connection he mentions an interesting feature of the use of electro-magnets with the traveling cranes for lifting plates and other iron material. With electro-magnets, used instead of hooks or chains, there is no difficulty in piling plates or shapes on top of each other and very close together. Obviously, with hand labor, there would have to be allowed sufficient room for the men to get around the piles, and, as a matter of fact, all the material would practically have to be stacked on edge.

The round-bottom fire bucket has a rival. The purpose of the round bottom, to prevent the use of the bucket for general purposes, being so easily overcome by making a dent in the bottom to get a flat place, has inspired the cone-shaped bucket. The bottom of the new bucket tapers to nothing and there is no point to set it on, apparently. It is, in fact, a bucket without a bottom. The driver of the mill wagon illustrated how easily the best intentions are frustrated. He wanted to water his team, and used one of these buckets. At the pump there was a box to place the bucket on, and it happened there was a knot hole in the box. The point of the bucket was put in the hole, and it stood up as well as any other old bucket. It is a poor mill man who cannot keep up with the inventors.—*Woodworker.*

"Meteorit" is the somewhat fanciful name given to an aluminum alloy that is much harder than pure aluminum, which is claimed to have all of its good features and to possess several additional ones. Its specific gravity is about the same; it is not affected by acids, the atmosphere or sea-water; it can be cast like cast iron and has eight per cent. greater strength; it can be rolled hot or cold and does not become brittle when hot; it has nearly the conductivity of copper; will keep a high polish and can be electroplated. The *Mechanical Engineer* states the above and says that the new metal is made by W. Rubel, of Germany. We sincerely hope that more will come of this "discovery" than has developed so far from the many other wonderful alloys with which we have been regaled during the last few years.

One of the most interesting features of the new plant now being erected by the B. F. Sturtevant Company at Hyde Park, Mass., is an elaborate testing plate for its engines. With an output of a thousand engines or more per year this is an essential feature of a careful system of manufacture and testing. The plate, or more properly the plates, will be supported upon a series of heavy parallel walls between which steam and exhaust pipes are carried, so that at almost any point in the entire area of the floor, measuring about 30 feet by 60 feet, steam and exhaust connections may be made to any engine. Testing facilities will be provided, and a transfer crane overhead will make it very simple to locate or remove the engines. The same crane will transport them to the packing department, and thence load them directly upon cars which traverse the end of the building.

It is not easy to obtain satisfactory results in the use of cement in cold weather, owing to its failure to set and harden. The crystallization of cement, which occurs in the process of hardening, is retarded by cold and hastened by heat. Taking 60 degrees Fahr. as normal temperature, experiments show that the setting of cement is accelerated by 14 per cent. at 80 degrees and retarded by 114 per cent. at 40 degrees. The most important improvement in the use of cement in recent years is the introduction of ferro-concrete, in which, by embedding suitably shaped iron rods or wires, the tensile strength is increased ten-fold and the ability of the cement structure to resist tensile stresses is made as great as its ability to resist crushing. One of the recent uses of ferro-concrete is for concrete piles, which are practically imperishable and increase in strength with age. They have been employed with great success abroad in ordinary dock work.

The *Electrical Engineer* of London recently published an article by Mr. A. S. Cubitt on electrical speed indicators and gave the history of some unsuccessful attempts in this line. The object of these experiments was to devise an instrument that will reliably indicate at any moment the speed in miles per hour at which electric street cars are running. A successful and simple device of this character should be very valuable to motormen—and the public. We already have the Hoyer speed indicator for locomotives, but this is somewhat too expensive for street car use. Another speed indicator which should be popular with machine shops but which so

far as we know has not yet been invented, is one that can be placed in the tool-post of a lathe or planer and which will indicate the surface speed in feed per minute without the use of a watch or requiring any calculation. Such a device would be the equivalent of the tachometer much used in steam engine tests for indicating the revolutions per minute. The tachometer, however, is entirely too delicate and expensive for machine shop purposes.

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The saving of time that is sometimes effected at one stroke by the introduction of a machine into some class of work is something quite wonderful. An example in point is the rotary bevel shear which has come into use in boiler shops for shearing, splitting, beveling and forming the edges of boiler plates. Formerly it was necessary to shape the edges of all flanged parts such as domes, heads, furnace mouths, etc., by the slow and laborious hammer-and-chisel process. With the rotary shear, however, such parts are beveled and shaped in a small fraction of the time required by the hand process. The machine is adapted to work complicated shapes, and the action of the rotary cutters both feeds and cuts the stock. It is said that such machines will trim stock at the rate of from 400 to 500 feet per hour. In railroad shops it has been found, for example, that a door sheet, which required 420 minutes to shape by hand, can be shaped and beveled with the machine in ten minutes. Other characteristic work is done with a proportional saving of time.

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One of the consular reports sent by Mr. Murat Halstead, of Birmingham, England, a few months ago in regard to the automobile business, states that one of the novelties of the season is an arrangement of the steering pivots for the forward wheels of a car known as the Weller car, designed to resist the strain on the wheels when rounding corners. The manufacturer's explanation in a card in a motor paper is that the steering pivots are inclined forwardly as well as outwardly. The action of the steering wheels on a curve is complex, the effect on the two wheels not being the same. When rounding a curve to the right the outer or left steering wheel is brought up from the normal inclination of a wheel fixed to a regular form of pivot or axle when turning a curve to the vertical; but the inner wheel is still further inclined, thus throwing the weight of the vehicle inward upon its wheel base and putting, he believes, the wheels in the most advantageous position possible to withstand the stress produced by centrifugal force when rounding curves. The leaning action of the wheels toward the center of the curves is proportional to the radius of the steering circle and the object of the outward inclination of the pivots is to obviate the risk of strain on the steering gear when overriding obstacles.

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If it is not practicable to accomplish a result mechanically in one way it may often be done in another way equally as good and with great simplicity. The history of labor-saving appliances is full of examples. Not many machines duplicate the motions of the human hand, because it is possible to accomplish the same result in a far simpler manner. A case in point is a machine for opening letters that was recently patented by Mr. Henry C. Zenke, New York. A machine that would insert a knife under the flap of the envelope and rip it open, would be entirely too costly and complicated for ordinary use and it is quite doubtful if it could be made operative. This machine, however, simply *saws* the edges off the envelopes, thereby releasing the contents. The saw is mounted on the shaft of an electric motor and is of the end-cutting type, being made in the shape of a hollow cylinder or tube with the teeth on the end. In other words, the saw is of the same type used by coopers for sawing out staves. The envelopes are gathered together in a bunch with the top edges even and in this position they are passed before the saw. The saw is protected by a shield carrying a ledge on which the envelopes are laid and above which is a narrow slot where the saw is exposed.

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Consular Report No. 1,896 says that mine owners have predicted the entire exhaustion of the steam-coal beds in England within a generation. This possibility is deprived of some of its terror by the announcement that an electrical process has been discovered whereby peat can be converted into hard, smokeless steam coal which, while occupying less room in a ship's bunkers, will, it is claimed, hold its own against the best Welsh coal. According to a description of the process, the peat from the bog is placed in rotary cylinders, and after the water has been expelled by pressure, electrodes with electric wires attached are inserted, and the mass becomes the medium of the completion of the circuit. Heat is generated by the resistance offered, and this in turn gives the objective result sought, namely, a perfectly disintegrated or pulverized material which separates freely into particles and has suffered loss of none of the properties primarily contained in the peat. Kneading and teasing operations serve to bring the mass into a plastic condition, so that it contracts into any shape or size desired. The cost is said to be much below that of coal at the pit's mouth. An initial plant is to be erected immediately in Ireland, where one-seventh of the surface of the land consists of peat bog.

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Thawing frozen water pipes by electricity is a winter industry that was developed two or three years ago in northern cities having a rigorous climate, but during the past "old-fashioned" winter, it has assumed considerable importance in that part of the country generally experiencing mild winters. Water service pipes are rarely buried in the earth to a depth exceeding four feet, so when we consider that the ground froze to a depth of five feet or more in the vicinity of New York City, it is not to be wondered at that frozen water pipes were the rule rather than a novelty. The electric thawing process is rapid and one that requires little labor, there being little excavating required—generally none. The usual plan followed is to connect one terminal to the water pipe of the house having the frozen connection and the other terminal to the service pipe in the cellar of an adjacent house. A few moment's application of the current thaws the layer of ice next to the pipe, which allows the water to flow, the taps being left open for this purpose, and the flowing water completes the job. A current of low voltage and heavy amperage is required, which makes it necessary to employ "step-down" transformers when taking current from an alternating lighting circuit. Ten minutes is about the average time required for thawing out a system that would require the services of a gang of men for a day if the old method of digging and thawing with a fire was pursued. So much for modern methods.

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It is surprising to learn what elaborate instruments are sometimes devised for determining an easily established fact. A valued contemporary shows a detector, measurer and *recorder* of scale formation in the tubes of water-tube steam boilers which is alleged to have received the indorsement of the Franklin Institute to the extent of being awarded the John Scott Legacy medal and premium. The description is accompanied by a somewhat lengthy argument on the advantages of the device and the extreme difficulty (?) not to say impossibility of detecting scale without such a device save by shutting down the boiler. So far as we can see the same applies when this instrument is used. "The instrument consists of a tube serving as a frame having a traverse wheel mounted thereon, which rotates by contact with the inside of the tube to be measured, as it is passed through for the purpose of exploration. This wheel by suitable gearing rotates a disk on which is mounted a chart or dial. A movable arm opposite the traverse wheel is mounted on the frame, which acts as a lever, causing a reciprocating motion of a rod carrying a pen, which rests on the chart, the motion of the pen corresponding to the reciprocating motion of the arm," etc. Of course the vulgar engineer who pokes a tomato can through the tubes to see if they are free from scale or choked, is hopelessly behind the times; he should have one of these valuable instruments and carefully preserve sets of charts for future reference. In fact they might serve as the basis for an exhaustive paper accompanied by diagrams, etc., upon the value of "Daily Scale Records," etc!

The combustion of one pound of coal in a well-designed boiler furnace will evaporate from 8 to 10 pounds of water, which is considered a fair commercial rating. But in the purification of bad water or sea water by distillation the fuel cost of the direct process is practically prohibitive. By using distillers built on the so-called Yaryan multiple-effect system it is possible and practicable, however, to more than quadruple the evaporative power of a pound of coal, or rather to more than quadruple the product of distilled water. The steam from the main boiler is led into what to all purposes is another boiler, and by its condensation it evaporates the water containing impurities, the steam from which passes into another so-called boiler and repeats the operation. The result is that each drum acts both as an evaporator and as a condenser. The successive evaporations are made possible by maintaining a successively decreased pressure in each boiler. A Scottish firm, Mirrlees, Watson & Co., Glasgow, recently built two sextuple-effect distillers for the Egyptian government which yield about 45 pounds of distilled water for each pound of coal. Each plant consists of six horizontal cylinders arranged vertically, one over the other, the total height being something like 39 feet. The pressure in each shell is graduated, being less in each successive effect than in the preceding one, which makes it possible to boil the water in one by absorbing the heat of the steam in the preceding effect. The apparatus, of course, includes steam pumps for maintaining the circulation.

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The framework of the Darlington Hotel in New York, a structure designed to be twelve stories high, but erected to the eleventh floor only, suddenly collapsed March 2, causing the death of over twenty persons in the ruins. It was being erected with vertical columns of cast iron, and these are supposed to have been primarily responsible for the disaster, although it would probably be nearer the truth to say that it was caused by the use of poor and inadequate material, defective design and incompetent supervision. It appears that the building laws and regulations had been repeatedly violated and that the upper floors were very heavily loaded with building materials. The flanges of the cast iron columns were found to be, in large part, honeycombed and full of blowholes and the castings as a whole of poor quality. It is also affirmed that the flanges were not machined and that the bolt holes were cored instead of being drilled. The wreck is one that will cast additional suspicion on the use of cast iron members in tall buildings, and it is conservative to assert that the building laws should be amended so as to prevent their use except in such generous proportions as to make them of little or no advantage over rolled steel. Cast iron is too uncertain at best for close engineering calculations, but rolled steel is a material very uniform in the matters of section thickness and strengths. Again cast iron columns give a building very little lateral strength to resist wind pressure, which becomes a serious factor in tall buildings, but with steel frames the use of gusset stays provides for lateral strength admirably.

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The New York Rapid Transit Subway was started in May, 1900, and it is expected that it will be opened to the public next June. The work has been a colossal undertaking, not so much on account of the vast quantities of earth and rock to be removed, but because of conducting it in a crowded city through streets carrying a great volume of traffic and beside tall buildings whose foundations were threatened by the excavations. In addition there were the multitude of water pipes, sewers, gas mains, electric conduits and pneumatic tubes with their surface connections, etc., that had to be displaced bodily without interruption of their service or with as little as possible. This work alone is said to have cost the contractors fully $3,000,000. For the greater part of the route the tunnel was carried on by the "cut-and-cover" plan; that is, it was dug as a ditch and covered over by a roof carried by steel structural work. The tunnel is finished in white glazed brick or tile, and the stations are the same with colored trimmings, the color scheme being varied for each station. The white interior makes the lighting power of the incandescent electric lamps considerably greater than if any other color had been adopted. The lighting circuit is entirely independent of the power circuit, so that any break in the latter will not interfere with the lights, the latter being an accident that would do more to precipitate a panic than almost anything else that could happen. It was the failure of the lights that caused the greater part of the loss of life in the Paris tunnel horror of a few months ago. The lighting system in the Subway besides being independent of the power circuit, is composed of two circuits entirely distinct and having separate sources of supply. One circuit lights the west tracks and the other the east tracks. In the event of one breaking down the other circuit would still light the tunnel so that traffic could proceed.

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"Professions are not mines of wealth; those who have embraced them are not paid in proportion to their merits, anomalous as it may seem. Men have grown gray in the services of colleges without receiving more than a very small salary. Be this as it may, the shopman has by no means a poor outlook in comparison with many of the so-called learned professions—lawyers, physicians, and even clergymen. He can command now $3 per day, and much more if he is a skilled man; on piece and contract work he can make "good money," as the saying is. Few professional men make $3 per day in the early years of their careers, and there is nothing in the calling of any workman to debar him from civic or national honors if he seeks them. The only thing which prevents more young American men from taking up trades is the fancied stigma which attaches to a mechanic, so-called, among a certain class—one, by the way, whose verdict is of no importance from any aspect. If I had a life to live over I should devote five years to learning a trade first. I would go into a shop without giving any one a hint as to my intentions later, and would take what came, keeping an open eye and receptive mind for all within my field of vision. After such an experience I would go to a scientific school (if not outlawed by an age limit) and absorb knowledge as a sponge does water. As one benefit from this course, I would have a sound mind in a sound body, enabling me to study hard and to appreciate more readily the teachings of science. I could see exactly where it agreed or conflicted with practice."—*Egbert P. Watson in Engineering Magazine.*

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### PRESERVATION OF WOOD FROM FIRE AND DECAY.

A paper was read by Mr. Joseph L. Ferrell before the Western Society of Engineers, January 20, 1904, in which he reviewed his celebrated process for preserving wood from fire and decay. The process briefly consists of saturating the wood with a solution of sulphate of alumina under heavy pressure—450 to 600 pounds per square inch. Where structures already built are to be treated, the exterior surfaces are covered with an enamel which successfully resists the attacks of fire for a long time. For the system it is claimed: 1. The elimination of the property of inflammability from wood and other fibrous substances, by impregnation with a permanent non-combustible chemical. 2. The practical plating of wood surfaces with an enamel, all of whose constituents are insoluble and infusible. 3. The permanent protection from decay of all wood by impregnation with a chemical solution. The sulphate of alumina costs about 75 cents per 100 pounds and the strength of the solution is made about 15 degrees Baume hydrometer test. The process costs about $9 per thousand board feet. It preserves wood from the ravages of termites or white ants which are so destructive in tropical countries, and is believed to be an effective check to the teredo, which bores into the piles of wharves. The preservative effect of the sulphate of alumina depends upon its power to coagulate the albuminoids in the wood, thus stopping decay from internal processes and preventing the entrance of external influences to set up decay. The practical value of an effective means of preserving wood from the two destructive elements—decay and fire—makes this process of great interest. Mr. Ferrell has been granted the Elliott-Cresson gold medal by the Franklin Institute.

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### NOVEL PROPULSION SCHEME FOR BOAT.

The United States Consul at Birmingham, England, says in Consular Report No. 1899 that an English firm is introducing

a light and handy explosion motor for boats that is known as the "universal transferable steering propulsor," the invention of a French firm. The great advantage of this steering propulsor is that it can be readily applied to any existing boat, converting the same into a petrol (gasoline) launch, without the necessity of boring a hole through the stern post and supplying a permanent propeller shaft and stuffing box. It can be attached to a boat and removed from same without any modification of the boat itself. Anyone taking this "steering propulsor" to a lake, river, or the seaside may attach it to any boat he finds there that is within its range of power. A rudder is unnnecessary, the boat being steered by varying the angle the axis of the propeller makes with the keel. As the propeller can be completely turned around, a reverse action is given. It is authoritatively stated that a number of these transferable propulsors have been adopted by the navies of France, Russia, and Japan, and that a 12-horsepower propulsor has been successfully applied to a launch, which towed a 300-ton canal barge with a load of 150 tons of sand.

### EFFECT OF COMPRESSION ON FINELY-DIVIDED METALS.

The experiments of Professor Hof, of Witten, Westphalia, in determining the effect of compression on finely-divided metals, was briefly reviewed in a recent issue of *Engineering* (London); the results of these experiments are interesting and may possibly prove of practicable value.

Prof. Hof has so far confined his studies to the compression of powdered or finely-divided particles of one and the same elementary or compound substance, and his results are of interest to the engineer as well as to the scientist. He took turnings of steel, copper, bronzes, and chiefly of a white bearing metal which has the composition—83 parts of tin, 11 parts of antimony, and 6 parts of copper. His experiments have, as a rule, been made with about ½ pound of material, which he compresses in a steel cylinder, 2 inches bore, gradually increasing the pressure to 50 tons. With a piston pressure of 10 tons, acting on the circular base of 2 inches diameter, the structure of the turnings still remained distinguishable. But the final pressure of 50 tons produced a perfectly homogeneous block, demonstrating, as the author expresses it, that cohesion is nothing but strongly increased adhesion. Another shallow block, made in a cylinder which had a wider bore below than above, assumed the exact form of the chamber so perfectly that the block could be nickeled without further finishing. This is an important point, and Prof. Hof considers that it may prove profitable to press bushes instead of casting and afterward finishing them. The compressed material is, moreover, denser than the casting. The presence of pores in ordinary white metal indicates that compression must be possible. In the specimens previously alluded to, the density rose from 5.67 to 6.85 and 7.15, the height decreasing from .90 to .74 and .69 inch under the pressures of 10, 30, and 50 tons respectively. In further experiments, the pressure was slowly increased by ten steps of 5 tons, beginning with a pressure of 5 tons. The specimens had in this case a diameter of 1.59 inch. The limit of compressibility was nearly reached when the pressure became equivalent to 25 tons per square inch. When turnings of white metal such as can be bought are melted down, there is always a considerable waste owing to oxidation, and the waste is, of course, much smaller when blocks are fused. Prof. Hof has observed that this difference in the loss by oxidation of the finely-divided mass and of solid blocks almost disappears when the material has been subjected to heavy compression.

### ALUMINUM WELDING PROCESS.

Although the uses of aluminum are constantly increasing—also the total consumption—it is, in some ways, an unsatisfactory metal for practical purposes. Its deterioration under the influence of salt water and the lack of a reliable solder have had a serious influence on its use in what otherwise would perhaps have been its largest field—the kitchen. This defect as to being soldered is a curious one. A number of aluminum solders have been compounded that seemed at first to be all that could be desired, but the test of time has invariably proved their insufficiency. While it is possible to solder aluminum, as has been repeatedly demonstrated, the joint is *not permanent*. Only recently, samples of aluminum soldering were submitted to us, which comprised aluminum soldered to aluminum; aluminum soldered to steel; to brass; and to copper. All the samples were firmly united and to one not familiar with the peculiar joint deterioration referred to, they seemed to answer perfectly to the demand for an aluminum solder. But the crucial test is to submit such pieces to a water bath for a few days. They will (as did these and as will all others so far as known) separate under the electrolytic action that is set up. This, of course, makes it impossible to maintain a soldered joint in vessels containing water, and if the joint is subjected to atmospheric influences alone, the parts will separate just the same, only the action is longer delayed.

Welding, however, seems practicable for aluminum rods, tubes and possibly for sheets. The Cowper-Cowles process, which requires no flux and no hammering of the joint, is attracting some attention. The aluminum parts to be welded are held in the desired relation by suitable clamps which can be forced together when the welding heat is attained. The heating is accomplished with an ordinary benzine lamp such as used by plumbers and tinners, or by other convenient means. As soon as the welding heat is reached the clamps are forced together, causing a ring of metal to be expanded around the joint and then the heat is instantly shut off by a screen interposed for the purpose while a spray of water is directed onto the weld to cool it. The ring of metal referred to is largely composed of aluminum oxide and is afterward filed off. Welded aluminum rods show by test an elastic limit of 8,000 to 15,000 pounds per square inch and an ultimate strength of 14,000 to 22,000 pounds. This being true, it appears that the best way of overcoming the aluminum soldering difficulty is simply not to solder but to weld.

### FOREIGN WARES IN CHINA.

*Century*, March, 1904.

"The Chinese peasant is no longer content to burn bean oil; he wants kerosene. In scores of humble Laos homes I saw American lamps costing twenty rupees apiece, and a magistrate proudly showed me a collection of nineteen of these shining articles. The narrow streets of Canton are brilliant with German and American chandeliers, and myriads of private houses throughout the empire are lighted by foreign lamps. The desire of the Asiatic to possess foreign lamps is equaled only by his passion for foreign clocks. The demand for clocks is insatiable. I counted twenty-seven in the private apartments of the Emperor of China, and my wife nineteen in the bedroom of the Empress Dowager, while cheaper ones tick to the delighted wonder of myriads of humbler people. The ambitious Syrian scorns the mud roof of his ancestors, and will be satisfied only with the bright red tiles imported from France."

### DANGER OF DEFECTIVE PIPING IN STEAM PLANTS.

*Cassier's Magazine*, March, 1904, p. 463.

The rupture of a 6-inch steam pipe, which caused considerable loss of life and damage to property, is reviewed by Mr. Francis B. Allen, of the Hartford Steam Boiler Inspection and Insurance Company. A large defective steam pipe is almost as potent a factor for loss of life within the steam plant itself as a defective boiler, its destructiveness being restricted to a lesser area only. The pipe which burst was to all appearances sound, but the accident revealed that the weld was defective for a considerable distance. The pipe had presumably been subjected to the usual hydrostatic test at the mill, and it had been subjected to a hydrostatic test of 150 pounds per square inch shortly before the explosion. If the pipe had been as strong as it should have been with a perfect weld, it would have had a factor of safety of at least twenty at the test pressure, but as it was, it burst with a boiler pressure of only 120 pounds per square inch.

There was no way to identify the mill from which the pipe turned out, the distinguishing marks of the different pipe manufacturers being applied with paint, which is readily

rubbed off. Mr. Allen recommends that the manufacturers stamp all pipe so as to indicate the manufacturer as well as the quality of the pipe. As the case now stands the steam piping of a plant is "a weak link in the engineering chain," and so long as unknown conditions prevail as to piping, so long will there be an uncertainty as to its safety.

### FLYWHEEL GYROSTATIC EFFECTS AND BROKEN CRANKSHAFTS.

*Horseless Age*, March 2, 1904, p. 241.

A correspondent makes the rather interesting observation that perhaps the frequent breaking of automobile crank shafts is due to the gyrostatic action of the flywheel in connection with the swaying or rocking motion of the car on uneven roads. No one who has ever made experiments similar to that described in the communication will doubt that there is an enormous force opposed to any change in the plane of a rapidly rotating flywheel. When one of the wheels of the car drops into a depression in the road or passes over an obstruction, the plane of the flywheel must necessarily be displaced, except in so far as the action of the body springs intervenes, and it may happen that the additional strains thus placed on the crank shaft near the flywheel are in the same direction as, and add directly to, the normal working strains. Under these conditions it is really not surprising that crank shafts should occasionally break off close to the flywheel, particularly in single cylinder cars, which have usually very heavy and large diameter flywheels in proportion to the strength of the shaft.

About a year ago it was shown in our columns that the gyrostatic action of the flywheel has a tendency to cause a car to skid, and now this same action is shown to produce excessive strains on the crank shaft, and may cause it to break. It will thus be seen that it is very important to reduce this action as much as possible. Evidently, if the plane of the flywheel is transverse to the length of the car, it will be deflected considerably less when one of the wheels drops into a hole than if the plane of the flywheel were parallel to the length of the car. Consequently any arrangement of the engine by which the plane of the flywheel comes lengthwise of the car is, from this point of view, preferable.

### TURBINES AND SUPERHEATED STEAM.

*Electrical Review*, February 26, 1904, p. 361.

In the opinion of Mr. W. H. Booth the causes for the economy of superheated steam in turbines and reciprocating engines are entirely different. Superheated steam is valuable in the steam turbine because it permits of a large expansion and a large ratio of expansion does not entail the loss that would occur in a reciprocating engine. In the cylinder of the reciprocating engine there is a constant action and reaction in progress between the steam and the metallic surfaces, causing cylinder condensation which increases the steam consumption from 30 to 50 per cent. Superheating the steam reduces this loss to a considerable extent.

It has long been boasted that the steam turbine avoids this very serious loss. Every part of the turbine is at the same temperature as the steam which is passing by it, and the passing steam is always at a uniform temperature. That this is so, subject to some slight limitation, is fairly certain. There is, no doubt, a certain conduction of heat along the shell and along the rotor from the initial toward the exhaust end, but to what extent this changes the temperature of the metals is not clear, for each transverse section of the parts is receiving heat and passing it onward, so that it would seem that the finally exhausted steam is acquiring heat from the last portion of the machine at the expense of heat abstracted from the first or initial end. The inference to be drawn is, that there will be a certain, if small amount, of initial condensation of steam in the first few inches of a turbine of the Parsons type, and that this small amount could be prevented by superheat. But, apart from this, there is no need for further superheat to take care of the steam dryness, for the steam will only lose such heat afterward as becomes converted into work. There is little gain to be secured in the steam turbine after a superheat of 140 degrees F. has been passed and it is still behind the reciprocating engine in economy. This proves that the reciprocating engine owes its economy entirely to the steam tightness of its working parts. It lets no steam escape without doing work, except what escapes by becoming water. The losses of the reciprocating engine when in good order are all of the thermal order. These losses affect the turbine comparatively little. Yet the turbine cannot yet be said to have come up to the performances of the reciprocating engine. There must be a reason for this, and the most obvious reason is leakage, which must, therefore, be enormous; from a quarter to a third of the steam which enters the turbine must escape ineffectively by leakage.

Such being the case, the future progress of the steam turbine must be in the direction of reducing its steam leak losses, for there is no gain further to be expected from superheat after 150 degrees F., or thereabouts, except the fractional and calculable gain shown by the formula $\frac{T - T_1}{T}$. This gain can only be secured by enlarging the machine to take the steam of lighter density and expand it to lower final pressures. A long range of expansion seems to suit the economy of the steam turbine, perhaps because in the long or Parsons forms some of the leakage past the earlier blades is caught up at a later point. But if, as claimed, there are some expansion troubles with turbines of the long variety, it would appear rational on this score to reduce the length to a minimum and endeavor to prevent leakage. Absence of rubbing contacts has been held up as the saving grace of the turbine, and rubbing parts have been held to constitute a fatal bar to any final success of the ordinary piston engine. But there do certainly appear good reasons to suppose that a turbine with actual contact parts so designed as to stop leakage would at once take the lead of any reciprocating engine, and would do so with steam superheated not more than 150 degrees F. The question has been asked: "Is the turbine nearer its limit of economical performance than the reciprocating engine?" With our present lights, we can only reply in the affirmative, but it can also be said that a non-leaking turbine would be *facile princeps* with steam of far less temperatures than its rival.

### PACKING OF MACHINERY FOR EXPORT.

*Abstract of Paper Contributed by Mr. Paul Roux to the American Chamber of Commerce, Paris.*

An American machine has much to pass through between the producing factory and its final arrival at the works of the purchaser; cartage, transportation by rail and by sea, transhipment, loading and unloading, Custom House examination, and, perhaps, storage for considerable periods in French warehouses. Its packing comprises the series of operations which have for object the preservation of the machine in good condition up to the time of final delivery. The care with which these operations are carried out, and combined, may not only largely affect their own cost, but also the expenses of transportation, custom dues, and storage, and these expenses, in the case of machinery exported from the United States to France, may amount to a considerable percentage of the selling price.

#### Preparation of Machines.

All machine-tools after having been completely assembled, inspected and tested in practical running, should be more or less completely dismounted, before packing. It is impossible to lay down fixed rules in this regard, as the extent to which a tool should be dismounted varies with each machine; or, rather, with each class of machinery. The manufacturer must take into consideration the resistance of the tool and its various parts to rough handling in transportation, and decide upon to what extent it should be dismounted to insure safety. It must be remembered that whilst the packing-case will protect a machine against blows which it may receive when in a normal position, it offers little protection against side or abnormal thrusts resulting from an overhanging position. Great care must therefore be taken to see that no part of a machine is in contact with the sides of the case that is not fully able to withstand the rough handling to which the case

may be subjected. The feet of a lathe bed, the base of a shaper, or of a milling machine, may be readily broken by the packing case falling, even lightly, on one of its corners, and without the latter showing any external evidence of the fall.

A most important consideration to be taken into account when dismounting a machine is its volume or cubage when packed for shipment. Marine freights are generally reckoned at so much per ton weight, or per 40 cubic feet, at the option of the ship. The exporter has, therefore, every interest to see that the weight, which cannot, of course, be varied, does not occupy a space greater than 40 cubic feet per ton. Nearly all machines, when not dismounted, make up into packages greatly exceeding 40 cubic feet per ton, and even under the best conditions can rarely be packed in cases equivalent in weight and volume. It may therefore be laid down, as a general rule, that every effort should be made to reduce the volume as much as possible by dismounting all projecting parts which increase the over-all dimensions of the packages. On the other hand, the difficulty of assembling parts requiring accurate adjustment must be taken into account, and the exporter must use his best judgment in deciding at what point the difficulties of setting up the machine will outweigh the economy realized by reducing the volume of the package.

This question of reducing the cubage is worthy of the closest attention of American manufacturers, as the freight from the United States to French ports is extremely high by the direct lines, while the extra duties charged upon goods arriving indirectly more than counterbalance any savings in transportation charges. The cost of transportation is, therefore, an important factor in the cost of a machine when delivered in France, and the economy realized by paying close attention to the volume of packages may form an appreciable portion of the profits.

The maximum weight of each package must also be carefully considered; freight charges—computed, as has already been shown, according to weight or volume, as may be more profitable to the carriers—are increased very considerably when the weight of individual packages exceeds a certain limit. For instance, the rate for packages exceeding 4½ tons in weight, is double that for packages weighing less than two tons. This increase varies according to the steamship line, but is imposed by all, and must therefore always be taken into account.

In addition to its effect on the actual freight charges, the total weight per package when exceeding a maximum of about two tons, involves extra charges for loading and unloading. These charges vary according to the equipment of the ports of departure and arrival, and are often very considerable—as it may be necessary to move the vessel under a dock crane, when one is available, or to get up steam on a floating crane to handle the heavy weights.

To sum up, it will generally be advantageous to dismount a machine weighing over two tons in order to pack it in several packages, each weighing less than this maximum. Care must be taken, however, that the total tonnage or cubage of the several packages does not exceed that of a single case, and that the difficulties of assembling the machine at destination do not more than counterbalance the economy realized on transportation charges. It is also profitable to dismount a machine weighing either more or less than two tons when this secures a considerable reduction in volume, and when, as is generally the case with machine tools, the cubage exceeds the limit of 40 cubic feet per ton.

### Dismounting Fragile Parts.

It is generally necessary to dismount fragile projecting parts, even when this will have no influence on the volume or weight of the packages. While it is true that these parts will be properly protected by the packing case during transportation, still they run the risk of being bent or broken during the operations of unpacking and setting up the machine. It is therefore preferable to remove them, and to pack them in one or more separate boxes secured in the principal case. All delicate or fragile parts which cannot be removed should be carefully protected against rough handling during unpacking. All screw threads should be carefully covered with wood or rags; all tapped holes, oil-holes, and, in general, all openings through which dirt can reach the interior of the machine, should be carefully closed with wooden plugs.

Manufacturers are especially urged to tag all pieces which may have been removed, with labels fully explaining their position on the machine. This precaution may appear exaggerated and useless, if it is considered that the machines will only be assembled by mechanics understanding their construction, but certain American machines are novelties to many factories, and besides, before arriving at the works of the purchaser, the machine has to pass through the Custom House, and sometimes to be exhibited in a sales room. Under these conditions, it is necessary that people, unfamiliar with the type of machine, should know exactly the position and function of each of the detached parts.

### Preservation.

When a machine tool has been properly dismounted and divided for packing, the very important operation of protecting the finished parts against rust must be carried out. Lack of care and attention in this operation may have very serious consequences. It is not necessary to point out what serious effects rust may produce on the finished parts of a machine; it should be remembered that after having passed three or four weeks *en route*, often badly protected from the rain, and always subjected to the effects of dampness, a machine may remain during long months in warehouses before being unpacked, and it is easily seen in what condition a machine may be found if the finished surfaces have not been protected against rust by a thoroughly efficient coating.

There are two things to be considered in this question of protection—the nature of the protective coating, and the method of applying it. Without stating what the composition of the coating should be, it is urged that this should be sufficiently fluid at the time of application to permit it to reach all parts of the surfaces to be covered; that it should be entirely free from all trace of acid, in order that it may not attack the metal. It should dry very rapidly, in order that no surface should be exposed accidentally through chafing *en route* or careless handling in the Custom House. It should be readily dissolved with oil, petroleum, or turpentine when the machine is ready to be set up at its final destination.

The coating should, of course, be applied carefully to all polished surfaces which can be reached by the atmosphere, and care should be taken that the coating is intact after the machine has been packed—that is to say, when the packing case has been constructed around the machine. It very often happens that the packers carefully coat all polished parts of a machine, but that more or less of the coating is removed during the handling necessary for placing the machine in its packing case, or by contact with the interior braces. The effects of this negligence are generally very serious, because the parts thus exposed are promptly attacked by rust, and the machine cannot be put in perfect condition, even if this be possible, except by long and costly work. Polished surfaces which are in contact with each other should not be coated; they will be sufficiently protected by the lubricating oil applied for running the machine. Likewise oil holes should be free from the coating composition, as it is most difficult to completely remove it later on.

Finally, it is recommended that this coating be not applied to any finished parts, which, by their position in the machine, are completely protected from all exterior contact, and which are so situated that the removal of the protecting coat would be difficult. For these parts the employment of vaseline or solidified oil is suggested, as this can be readily removed, and, even if not removed, cannot affect the working of the machine. The only precaution to be taken is that the vaseline and oil should be entirely free from acid. As an example, inclosed gearing, such as in the headstock of a lathe, can be protected in this manner against rust. Vaseline or solidified oil may also be employed for protecting such small detached pieces as may be inclosed in a separate box.

### Packing Cases.

The packing case must fulfil two requirements; it must effectually protect the machine against all shocks and injury during transportation, and must facilitate the handling of the

machine—that is to say, the packing case must be at the same time a covering and a vehicle.

In order to fulfil this double requirement, the case should be specially constructed, and, without fixing general rules, as the details of construction will vary considerably with the forms of different types of machines, the essential requirements will be given for packing cases containing a machine which is of a weight too great for moving by hand.

The bottom is the most important part of the case, considered as a vehicle. If this is well designed, it will not only facilitate handling during transportation from the United States to France, and contribute greatly to removing risk of injury, but it is the only part of the case which can be utilized in France if, after remaining in show rooms, it is to be shipped by rail to its final destination. The bottom should therefore be sufficiently strong to carry the total weight of the machine, without the assistance of any other part of the case, when balanced on a roller. It should be constructed with two longitudinal battens, in order that the case may be moved on rollers when cranes are not available, and these battens should be beveled at the ends to facilitate their employment. Transverse planking, spiked to the battens, forms the bottom of the case. On the bottom, constructed as indicated, two frames should be built around the machine, dividing the length of the case in three parts, in such manner as to support the pressure of ropes or chains when handling with cranes or other hoisting apparatus. These frames will, at the same time, act as supports for the interior braces, and as lateral supports in case the package is laid on its side, which often happens in spite of instructions. Around these principal elements are built the sides, ends, and top of the case, which are designed simply for protecting the machine generally. In constructing the packing case, the remarks already made regarding its volume, must be borne in mind. This volume is computed from the over-all dimensions, and often a bolthead, or a batten, badly placed, will largely increase the cubage.

In designing the packing case, it is very necessary to make provision for the examination of the machine in the Custom House, and even for removing it completely. It is absolutely necessary in all events to arrange an opening in one of the sides or in the cover, through which the nature of the machine may readily be seen. This opening should be large enough to permit the examination of all parts of the interior of the case, and to permit the passage of a lantern, if required. It should be closed by a cover secured with screws. To allow for removing the machine completely from the packing case, in order to determine the net weight of the machine for the Custom House, it should be arranged so that the packing and the unpacking may be readily and rapidly accomplished, without it being necessary to injure the panels. For this it is necessary that the top, and one of the sides, be secured with screws, instead of nails, and that the position of the interior battens and braces be indicated externally, in order that the screws and nails fixing them may be readily found.

It is especially recommended that the interior of packing cases be not lined with paper. Such a lining prevents the circulation of air, and if the machine be packed in a damp atmosphere, the humidity, which under other circumstances would have evaporated, will attack the metallic parts wherever exposed ever so slightly. Special attention is called to this point, as practical experience has demonstrated that effects quite unforeseen by the exporter have resulted from lining cases with paper.

### Lists and Drawings.

It is very necessary that the machine should be accompanied by a detailed list of the detached pieces contained in the packing case, which, on unpacking, will show whether any part has been lost during transportation, or during the Custom House examination. It is most indispensable that this list should be accompanied by a drawing or cut showing clearly the machine when assembled and ready for work. This cut should also show all accessories which are indispensable to the machine; for example, countershafts, keys and wrenches, change gears, etc. This cut, in lieu of which a drawing should be supplied, will permit the Custom House inspectors to convince themselves that the detached pieces actually form part of the machine; otherwise, these pieces may have to pay duties at a higher rate than the machine itself. If the machine has been taken apart and made up into several packages, a cut or drawing should be placed in each case, as in general all of the packages are not opened in the Custom Houses. These papers, lists, cuts, and drawings should be carefully enveloped in waterproof paper, and tacked inside the case near the small opening already mentioned, in order that they may be readily accessible. When the dimensions are such that the papers can be attached to the cover of the opening, this should be done.

### Exterior Marks.

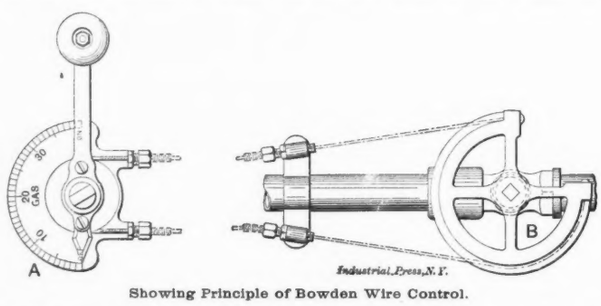
Once the packing is finished, it only remains to properly mark the cases for identification. All manufacturers know that a case should be marked legibly with identifying marks and numbers, the gross and net weight, the volume, and the name of the port of discharge, the latter in legible lettering at least 2 inches in height. It is only necessary to call their attention to the necessity of marking the absolutely exact net weight, as even a very small difference between the weight stated and the true weight may cause difficulties in the custom house; and, perhaps, the imposition of fines. The volume is determined by taking the three dimensions over all. In addition to these marks, indispensable for the transportation of the package, and which should, when possible, be placed on the sides of the case, it is recommended that on each end of the package, a short designation of the contents be added. These last-named inscriptions are absolutely necessary when the package is to be stored in a warehouse, as they permit of the immediate identification of a case containing a given machine. These inscriptions should not only indicate the type of machine, but should also give its size or number.

Finally, exporters are urged to paint a black circle around the heads of all nails and screws which should be removed in order to unpack the machine with the least work, and without injuring the panels and bracings. If the bottom of the case has been given the special form indicated above, there is little chance that it will be placed otherwise than upright; it is, however, better to add usual indications "top," "bottom," etc.

* * *

## THE BOWDEN WIRE CONTROL.

The Bowden wire control system has been quite extensively used in Great Britain, it appears, in the construction of bicycles and motor cars, and is applicable to a large range of uses where it is necessary to mechanically operate any device from a distance. It consists essentially of a stranded wire of great flexibility working within an armor of spirally wound wire of much thicker gage. The spiral wire covering, of course, is stationary, while the flexible wire works within it




Showing Principle of Bowden Wire Control.

and is connected to the controlling and operated devices. In general two wires are required as indicated in the accompanying cut, which shows the controlling handle at *A* and the stem of a valve in a steam or gas pipe at *B*. The distance separating the two may be considerable and it is not necessary that the connections be made in straight lines. It is being applied for working the inlet and exhaust valves of internal combustion motors and for other novel purposes.

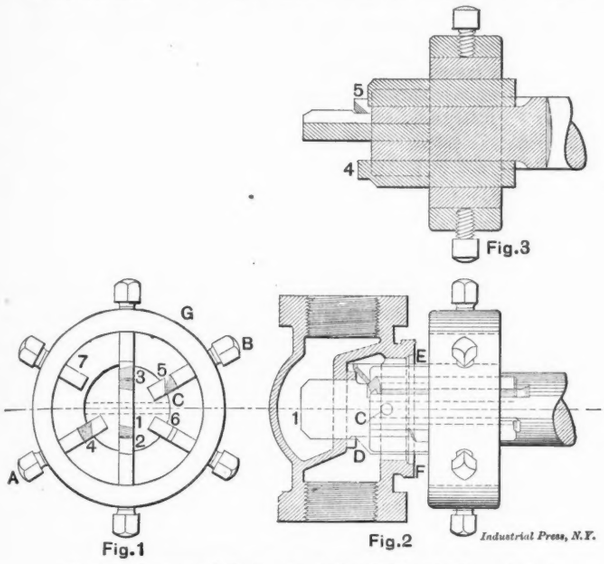
* * *

It is asserted that, under present conditions, the average wear of locomotive tires is 1-16 inch per 9,000 miles. This is a reduction of 2,000 miles within the past few years, and is due to heavier locomotives having greatly increased tractive power. It will be interesting to note what effect the advent of nickel steel tires will have upon average tire wear.

## SOME TOOLS USED IN THE MANUFACTURE OF GLOBE VALVES.

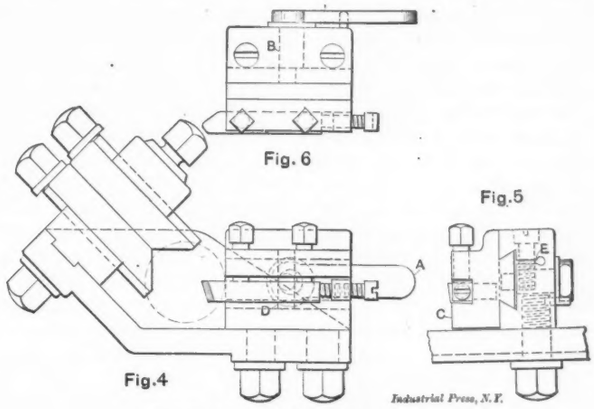
J. R. GORDON.

There is probably no part of the manufacturing field that has had closer pruning in cutting out superfluous operations and expenses than that of the manufacture of steam valves. The labor cost to manufacture globe valves in large quantities is surprisingly low to the casual observer, and to better figures already established would seem to be a difficult undertaking. It was in the hope of so doing, however, that the tools described below were designed. Aided by the modern design of turret lathes and special valve machinery and some of the many labor-saving devices that are on the market, and using intended in this article to give an extended description of the work of valve manufacture, but I have singled out a few tools that are somewhat special in their design and that may be readily adapted to numerous lines of work.




Tool for Boring and Facing the Body of Valve for Bonnet Seat.

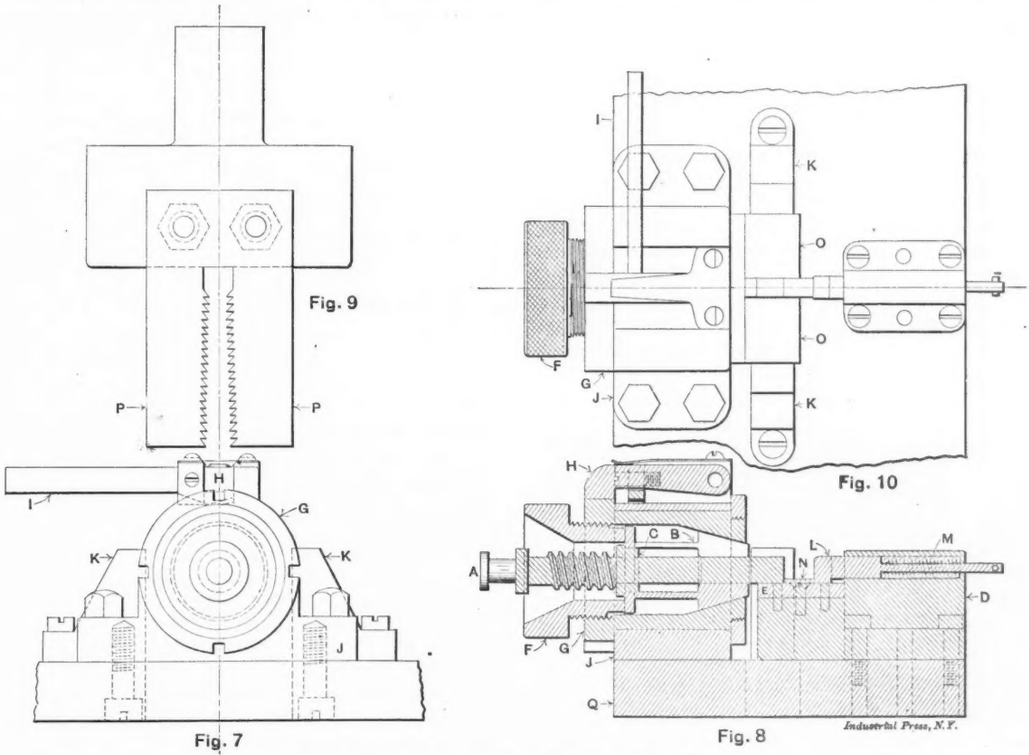
Figs. 1, 2 and 3 represent a tool which bores and faces the body part of the valve for the bonnet seat. Fig. 1 is the end view, Fig. 2 the side elevation, and Fig. 3 a cross section on the line *A B*, Fig. 1. The tool consists of a holder with a shank turned to fit the hole in the turret and with slots milled in to suitable depths to receive the cutting blades.




Box Tool for Finishing Valve Stems.

Over the largest part of the body of the holder a ring, *G*, Fig. 1, is driven on. In this ring and opposite the slots are setscrews that press against shoes which hold the blades in place. The blades are made to take out easily, but are supported against side thrust by the body of the holder.

The blades perform the operations thus: Blade 1 bores out the cored hole in the body, a cross section of which is seen with the tool entered in Fig. 2. This blade is held in the slot milled in the holder by the pin *C*. Blades 2 and 3 chamfer the disk seat inside and outside respectively. Blades 4 and 5, Figs. 1 and 3, bore out the body to receive the tap for the bonnet. Two blades are made, one to balance the thrust of the other; in addition to this work, blade 4 is lengthened to face off the disk seat *D*, Fig. 2. Blade 6 bores the recess *E* for the bonnet seat, and blade 7 faces the bonnet seat at *F*.




Punch and Die for Broaching the Square on Valve Stems.

high-speed steel wherever practical for the cutting tools, it is believed the object desired has been attained. At the time this is written the tools have been under trial long enough to demonstrate their value. A few slight improvements suggested by usage are embodied in the drawings; otherwise they are practically the same as the original tools. It is not

Thus the whole seat is finished with one tool. The advantages of this style of tool are that once made it is cheaply maintained, and when any of the blades are dull they may be quickly removed, by loosening the screws that hold them, and sharpened without losing the setting of the machine. The life of the tool is great, since all the grinding can be done on the end of the blades.

Fig. 4 represents the front view of a box tool as constructed by a Cleveland firm, showing also the front view of a sliding tool holder. Fig. 5 shows the side view and Fig. 6 the top view of the holder. With the ordinary box tool, in order to leave a finished surface after the cut is taken it is necessary to back the tool off as slowly as it was driven forward; but this tool obviates this disadvantage. The valve stem which is seen at *A*, Fig. 8, is first chucked by the disk end and the casting finished on the shank part and sized for the thread at the same time, using two tools in the box tool. After the cut is made the lever *A*, Fig. 4, is thrown to an upright position, which, acting on the cam *B*, causes the tool slide *C*, Fig. 5, to move back about 1-16 inch. The cam *B* engages in a slot *D*, Fig. 4, milled across the dovetail in *C*. The bottom of *C* is relieved slightly to permit free movement over the base. Adjustment for wear and freedom of movement is made by slotting the body of the holder *E*, Fig. 5, and taking up the spring with screws. A glance at the drawing will show the method of holding and adjusting the cutting tool in the holder.

Figs. 7, 8, 9 and 10 are drawings showing the construction of a punch and die for broaching the square on the end of the stem to receive the wheel or handle. *A*, Fig. 8, shows the stem in position to be operated upon. It is held in position by the spring chuck *B*, and its position is further determined by the stop bushing *C*. This bushing also serves to center the stem. The stem is supported against the thrust of the cut by the raising block *D*. To prevent wear, a hardened steel piece is fastened to *D*. The spring chuck is forced to its work by the knurled screw *F*, which screws into the spindle *G*. *G* is locked against movement until otherwise desired by the catch *H*, which is in turn opened by the lever *I*. The catch *H* engages in the four slots milled in the flange of the spindle, as shown in Fig. 7. The spindle catch, lever, etc., are housed in the bracket *J*. *K K* are guides to support the cutting blades of the punch against opening thrust while the cuts are being made.

The act of putting the stem in position forces the plunger *L* back, the spring *M* in the housing being light enough to offer but slight resistance. After the first cut is made the spindle is unlocked and a quarter turn is made which brings the stem in position for the next cut. As soon as the stem is revolved into place the shoe *N* on the plunger *L* springs under it, where the cut is made, and supports it for the second cut. The shoe is made slightly tapering to permit a certain entrance under the stem. *O O*, Fig. 10, are openings in the bed to permit the passage of the punches *P P*.

The parts described are mounted on a machine steel plate *Q* which is placed directly upon the bed of the press. The die took up so much room that this was necessary. The stroke of the press is 3 inches and the length of the cutting part of the blades in the punch is 2½ inches, with 21 teeth cut in each. The amount of metal to be removed on each side of the stem is about 1-16 inch. The first tooth on each blade removes about 1-100 inch, and this leaves about .0025 for each of the remaining teeth to remove.

This tool performs its work very rapidly and efficiently.

* * *

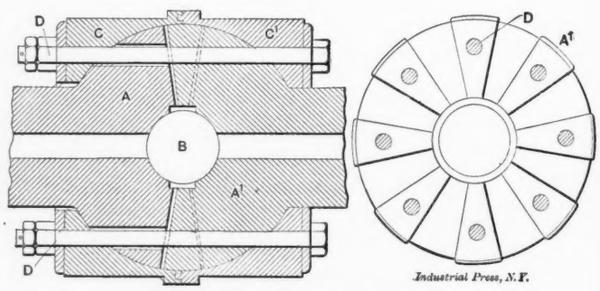
## PERMANENTLY EXPANDING CAST IRON.

Most practical men, familiar with steam boiler operation, are, no doubt, also quite familiar with the swelling, warping and permanent enlargement of furnace grate-bars when the fireman neglects to keep them free from clinker or allows the ash-pit to fill up occasionally and choke the draft. Under such conditions the bars are alternately hot and cold, and the result is that they soon become permanently distorted. The remedy, of course, is to keep the grates clean and the ash-pit clear, but, strangely enough, the subject of the permanent expansion of cast iron seems never to have been seriously investigated until comparatively recently. It is referred to at length in an interesting paper read by Mr. A. E. Outerbridge before the Franklin Institute, January 7, 1904. He showed, among other samples, two test bars each of which were originally 14 13-16 inches long and 1 inch square section. One of the bars had been caused to *grow* to a length of 16½ inches and 1⅛ inch section! This means an increase of bulk of over 40 per cent. and a corresponding decrease in the specific gravity, the expanded cast iron weighing at the rate of 375½ pounds per cubic foot, while originally it weighed about 444¾ pounds per cubic foot. The bars treated were heated in a case-hardening furnace (provided with a pyrometer) while inclosed in pieces of pipe sealed with clay to prevent oxidation. When the temperature was limited to 1,200 degrees F., nearly one hundred heatings and coolings were necessary to cause a permanent expansion of 1 inch per foot. But when the temperature was increased to 1,450 degrees F. each heating and cooling caused an increase of 1-16 inch in length. Mr. Outerbridge then showed useful samples of work that had been expanded. The plunger of a small pump had worn until it was 0.006 inch under size; in five heatings and coolings it was expanded 0.045 inch in size or 0.039 inch more than required, thus giving ample material for grinding to size. Another sample was a "pin cam lever" made for a new machine. Some expensive tool-work had been put upon it, as well as upon a duplicate, the pattern having been made in two parts. When this "split pattern" was nearly finished it was found that an error had been made, and both halves were ¼ inch too short and 3-32 inch too narrow. The operator of the case-hardening furnace skilfully expanded both castings, without serious warping, to the required dimensions. A cast iron pulley originally 14¾ inches diameter was permanently expanded 3-16 inch diameter in four heatings; a blank gear 9 3-16 inches diameter was expanded 1-16 inch in five heatings; a bushing 3 9-16 inches diameter was expanded 3-32 inch diameter in fifteen heatings, etc.

* * *

## UNIVERSAL JOINT FOR PROPELLER SHAFTS.

The failure of many marine propeller shafts has been traced to defective alignment and flexure of the vessel when in a seaway. The usual form of shaft coupling is perfectly rigid, the ends being flanged and bolted together. If, instead, a coupling could be employed that would combine great torsional strength with a certain degree of flexibility and at the same time stand up well under a heavy end thrust, the effect undoubtedly would be a considerable reduction in the number of propeller shaft failures.




Universal Joint for Propeller Shafts.

According to the *Mechanical Engineer* Mr. Hiram S. Maxim has patented a marine shaft coupling designed to "fill the bill." Its essential features are shown in the accompanying cut. The ends of the shaft sections are enlarged into semi-spherical bosses, *A* and $A^1$, over which is fitted the two-part casing $CC^1$. Eight through bolts, *D*, hold the casing and the ends of the shaft together. The ends of the shafts are provided with clutch teeth cut with radial sides which engage and transmit motion. To take the end thrust a hardened sphere *B* is seated between the ends concentric with the exterior spherical surfaces. The coupling is very strong for its diameter, is symmetrical in form and possesses great torsional strength together with the desirable feature of limited flexibility.

# LETTERS UPON PRACTICAL SUBJECTS.

## ALLOYS OF HIGH TENSILE STRENGTH.

*Editor* MACHINERY:

I noted the article on Alloys of High Tensile Strength, by Mr. Herbert E. Field, in the February number of MACHINERY, and regarding this subject I will say that the foundry at the shops of the Rock Island Arsenal make a bronze that must test 60,000 pounds per square inch and they have had it run as high as 80,000 pounds per square inch. This is the bronze used on the 3-inch gun carriage, model 1902, that is built at this arsenal.

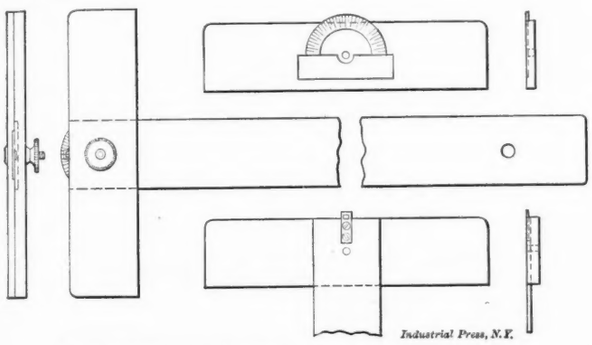
The treatment of this bronze as to purity, temperature of heating, method of mixing is as Mr. Field states it in his article. The composition differs though, from Mr. Field's; it is simply 66 2-3 per cent. copper, 33 1-3 per cent. zinc, and a touch of aluminum. No tin and positively no scrap for this bronze, which they call their No. 1. The elongation of this metal is 20 per cent. A. D. K.

Moline, Ill.

## ADJUSTABLE T-SQUARE WITH PROTRACTOR

*Editor* MACHINERY:

I have found the T-square illustrated to be very handy when laying out angular work such as is found in jigs and fixtures. It is not shown as anything new, for it is simply an adjustable square, but my object in sending same is to show the addition of a protractor which makes it much handier than most squares.




Adjustable T-square with Home-made Protractor Attachment.

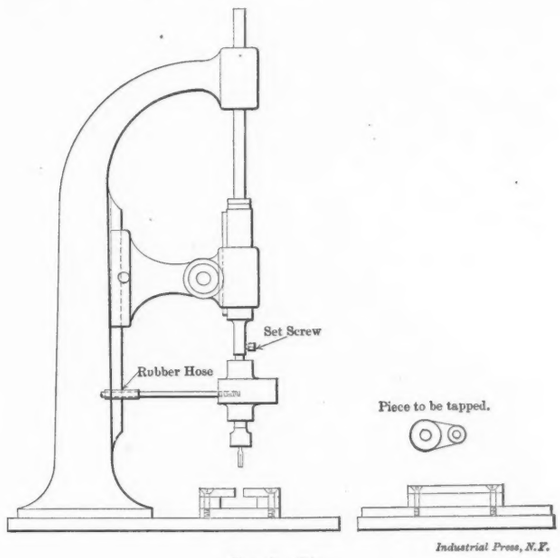
It will be seen that the protractor is inserted in the swivel portion of the head, the center portion of which was filed away, so that when it was sunk into the wood, there would be stock left around the bolt. The pointer was placed into the fixed head, but the index line was not scribed in position until after assembling, when true position could be found. C. E. J.

## THE DANGEROUS SETSCREW—A TAPPING RIG.

*Editor* MACHINERY:

The practice which I have noticed in many shops of putting a setscrew on the drill press spindle cannot be too strongly condemned. Besides being unsightly and a source of frequent accidents the screw will soon strip the thread in the spindle, necessitating the use of a larger screw. The object sought for in most cases is to prevent tapping attachment from dropping out. Besides being a bit heavier than an ordinary drill chuck it must also stand the shock of the reversing clutch, all of which has a tendency to pull out the taper shank. To hold it firmly it is only necessary to seat the taper firmly in its socket, which may be readily accomplished by simply holding a piece of babbitt under the chuck and tapping the other end of the drill spindle with a heavy, soft hammer. This is invariably effective in small, sensitive drill presses, and no further trouble in this direction will be experienced.

I recall an instance where the tapping attachment itself was pronounced "N. G." because of this very trouble. There were a lot of small cast iron links to be tapped, two holes in each, at the rate of about 2,000 a day. After discarding the setscrew and driving the shank into the drill spindle, as suggested, a slide was made consisting simply of three thicknesses of sheet iron screwed together, as shown in the sketch, so as to allow the free passage of the piece to be tapped. By clamping this slide to the drill-press table the necessity of locating the hole to be tapped and of preventing the piece from turning while being tapped, was entirely obviated. The same device was later used in connection with a friction chuck for tapping the same holes in steel, it having been found desirable to increase the strength of the links without increasing their size.




Tapping Rig.

I have always found that tapping by this method has the same advantage over horizontal tapping, as a vertical milling-machine has over a horizontal spindle milling machine, namely, the operator is better able to follow the work in his natural position than when he is bending over it.

New York. H. J. BACHMANN.

## EXPLOSION OF WATER FRONT.

*Editor* MACHINERY:

It would be hard to find a more inoffensive and innocent-looking machine than the ordinary kitchen range—but that it can have wild moments at times the photographs enclosed will show. They also will show that cast iron under steam pressure is apt to be dangerous.

The explosion of the water front shown in Fig. 1 took place at Worcester, Mass., on the morning of February 4 and caused damages to the extent of about $125. The hot water tank connected to the water front was located in a closet in a room adjoining the kitchen, the connecting pipes passing through two walls about one foot apart. A fire left in the range over night became so low that a fresh one was started in the morning, but the water in the tank was warm enough

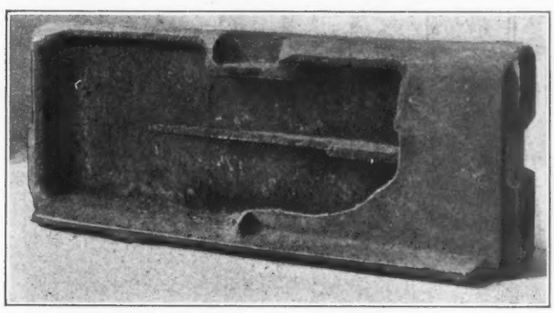


Fig. 1. Water-front of Kitchen Range after Explosion.

for bathing purposes and was used for such up to the time of the explosion. The explosion was terrific and not only wrecked the range but hurled the fragments against the walls sufficiently hard to split and crush the wood-work. The room was set on fire which, however, was easily extinguished

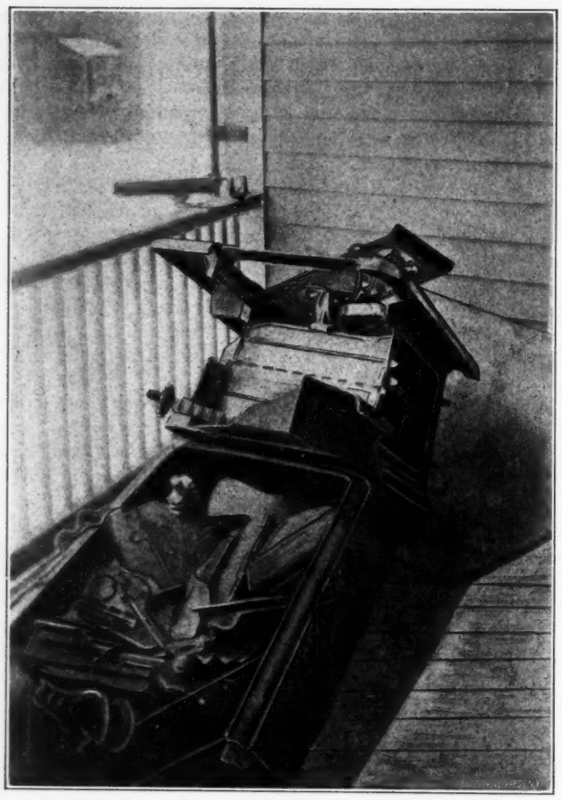


Fig. 2. Ruin of the Range.

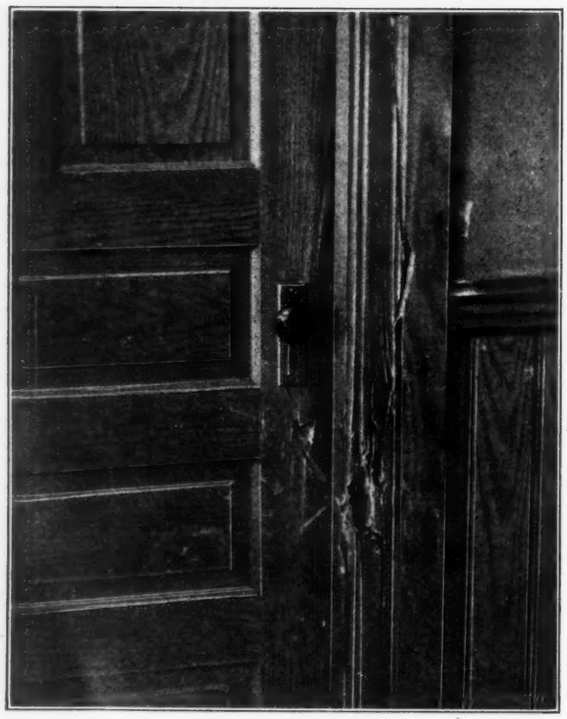


Fig. 3. Where one of the Fragments Struck.

as the floors were of hardwood. Two people were in the kitchen at the time of the explosion, but were not hit by the pieces.

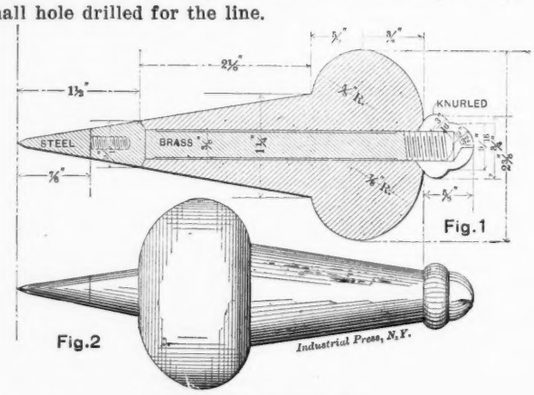
Fig. 1 shows the cast iron water front as it looked after the affair. Fig. 2 gives an idea of the wrecked range; those parts of the range not actually forced apart were cracked and broken beyond repair. Fig. 3 is where one of the flying pieces struck, and gives an idea of the force of explosion. It is supposed that either the pipes were frosted where they passed between the walls or that sediment collected at their juncture with the water front itself. A coil of pipe instead of the cast iron front would undoubtedly have prevented so serious a result, as it would simply have split, relieving the pressure without explosion. H. P. FAIRFIELD.

[In a later letter Mr. Fairfield says that since hot water could be and was used throughout the morning, no suspicion, naturally, was felt that all was not well with the pipes. The trouble, of course, lay between the range and the boiler. A number of similar explosions occurred during the past winter, which indicate that the water front kitchen range will bear close watching, especially in severely cold weather.—EDITOR.]

## ANOTHER PLUMB BOB FOR SHOP USE.

*Editor* MACHINERY:

I noted with interest the drawings and description of plumb bobs in the January number of MACHINERY, but find that the one shown in the sketch herewith has several advantages for shop use. If made of brass to the dimensions given, the bob will weigh about 1⅞ pounds, but it may, of course, be made any size to suit the user's taste. The body, cap and center pin are of brass with a small steel point screwed in, as shown in the details. The cap is knurled on the edge and has a small hole drilled for the line.




Plumb Bob for Shop Use.

The taper shoulder on the pin and cap causes the pin to center accurately, whether it is a perfect fit in the body or not. This arrangement permits of the body being reversed, when desired, as shown in Fig. 2, in which case it will come to rest more quickly than when used in the regular manner. When a light plumb bob is desired for working near a wall or in a small hole, the body may be removed entirely and the pin and cap alone used. S. M. PRESTON.

Ouray, Colo.

## DECIMAL THREADS.

*Editor* MACHINERY:

Since the publication of the article on cutting fractional screw threads in the November, 1903, issue, I have had a number of inquiries in regard to "decimal threads," meaning that the pitch is expressed in decimals of an inch. This means that a thread 4 to the inch or ¼-inch pitch would be expressed as .25 or 25-100 pitch. From the source of these inquiries I feel they come from government shops and that this method of designating is not common or likely to become so. Still, as it will not require much space to make it clear, I shall ask the editor for his further indulgence.

As in the case of the fractional threads it is only necessary to consider both the lead screw and the screw to be cut in the same terms, remembering that it is the "equivalent" lead of the lead screw that must be taken. This was carefully explained before and need not be repeated. It is an awkward way to designate a lead, but you can master it just the same. Suppose your equivalent lead screw is 5 to the inch. This expressed decimally would be .20 inch. Now if

the screw to be cut has a lead of .40 inch it is evident that it is twice as fast as the lead screw, and that the lead screw must turn twice as fast as the spindle. The ratio is 2 to 1 and a 48 on the stud and a 24 on the lead screw will do the work.

It is where the lead of the work and the lead screw cannot be expressed in a simple ratio that the trouble comes in figuring it out. Suppose the drawing calls for a thread .15 lead and you have the same lead screw as before. Then it is a case of 15 to 20, or dividing each by 5, is 3 to 4. Any gears bearing this ratio such as 24 and 32, or 30 and 40, will cut the thread. It often happens, however, that the lathe builders make lead screws that do not divide up in even decimals as the one taken. They are quite frequently made 6 to the inch, which gives a lead of .166666, etc. (as long as the sixes hold out). This is what raises a fog when we come to try and cut that .15 lead thread. The ratio is .15 to .166 (if we decide to only use three decimal places), which can also be called 150 to 166, as we must keep the same number of decimals. The ratio is a little over 1.1 to 1, and it is often easy to find gears for this ratio in an ordinary lathe equipment. Trying 40 and multiplying it by 1.1 we get 44, which we can probably find, but could not do it with any others in the train unless there happened to be 60 and 66 or 80 and 88. As the thread to be cut is a little faster than the lead screw, the large gear must go on the stud. But the thread will not be exactly the lead, as we dropped some of the decimals. Still it is the best we can do on an ordinary lathe.

One more example and I am through. Lead screw 6 to inch or .166 lead, and screw to be cut ⅜ or .375 inch lead. Dividing .375 by .166 we get 2.23 as the ratio. We will have to call this 2.25 or 2¼, even if it is not exact. Then trying a 24 as the smallest and multiplying it by 2¼ we have 54 as the gear for the stud. This is a case where common fractions are easier and more exact, as they come out even. Calling the lead screw 1-6 and the pitch of screw to be cut ⅜ we can reduce them both to 24ths and get 4-24 and 9-24. Then the ratio is 2¼ to 1, as we assumed before, after finding that the decimals did not come out right.

Decimals are very useful in many ways, but when it comes to figuring leads of screw threads they are not in it with plain, raw, common fractions. FRED. H. COLVIN.

## PUNCH AND DIE FOR FORMING THE BASE OF A STEEL RANGE.

*Editor* MACHINERY:

Having seen and read a great deal of late in MACHINERY about punch-and-die work I will describe a die which I designed for forming the base of steel range stoves that are made in our shop.

This die performs the second operation on the base which is already formed to the shape shown in reduced scale at *J*. *A* is the die-block upon which the steel sheet *J* rests during the operation. It is of composite structure, the four pieces, *G*, being placed at the sides and ends as indicated at *F*, which is a sectional view of the bottom die with the side pieces *G* in position. The top part or punch is shown at *B*. It is inlaid with steel strips of the shape shown at *H*, which form end and side pieces to match the pieces *G* in the bottom die. The pieces *C* are fitted across the channels in *B* to hold the steel end pieces and to complete the shape of the punch. The cushion plate *D* is fitted with side strips which project about ¼ inch below its base. This is indicated in the cross section of the cushion plate at *E*. The reason for having these strips on the cushion plate is that they drop into the previously formed groove in the sheet and over the edges of the die-block and hold the piece from jumping up when the side forming pieces move inward.

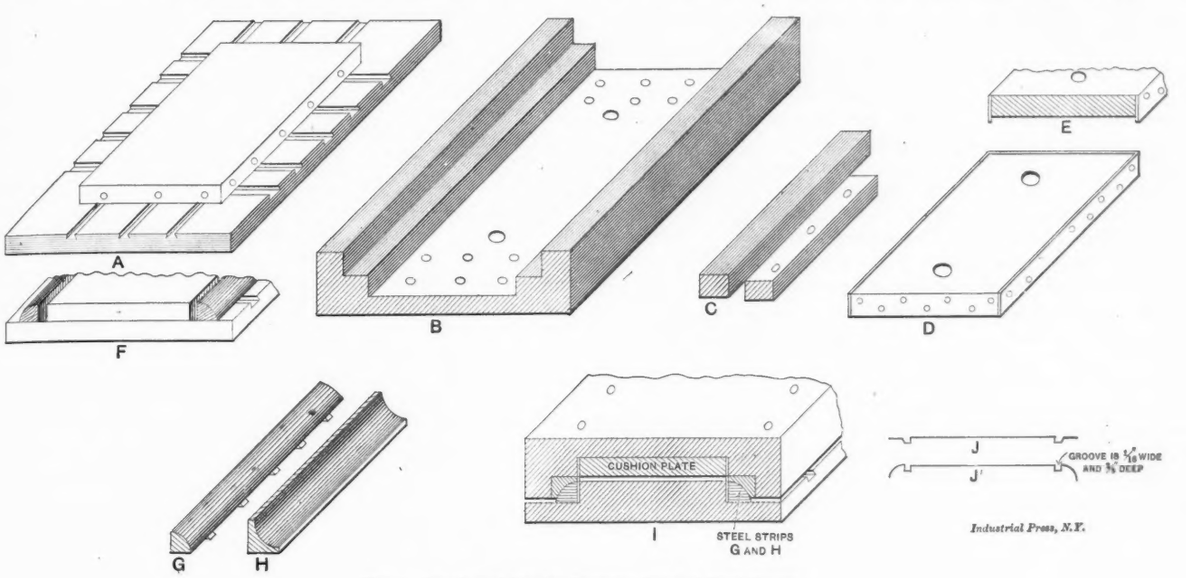



Fig. 1. Punch and Die for Forming Base of Steel Range.

The lower die plate *A* has dovetailed grooves planed at right angles for the reception of the similar shaped projections on the bottoms of the steel strips *G*. The holes shown in the elevated portion of *A* are for springs which shove the side pieces back when the punch ascends after the forming operation is completed. A section of a completed base is indicated in reduced scale at *J'* and a complete base is shown in the half-tone, Fig. 2. At *I*, Fig. 1, is shown a sectional view of the punch and die when closed.

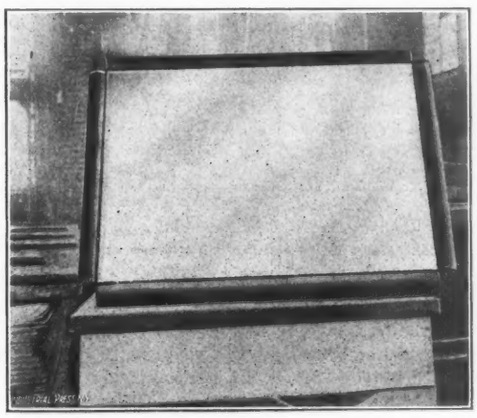


Fig. 2. The Base, after Forming.

This die is made for three sizes of stoves, the bases of which measure 29 x 20 inches, 31 x 20 inches, and 33 x 20 inches.

Lorain, Ohio. W. VAN ORMAN.

## TO CALCULATE THE SETTING OF THE DIVIDING HEAD WHEN CUTTING THE TEETH OF END MILLS.*

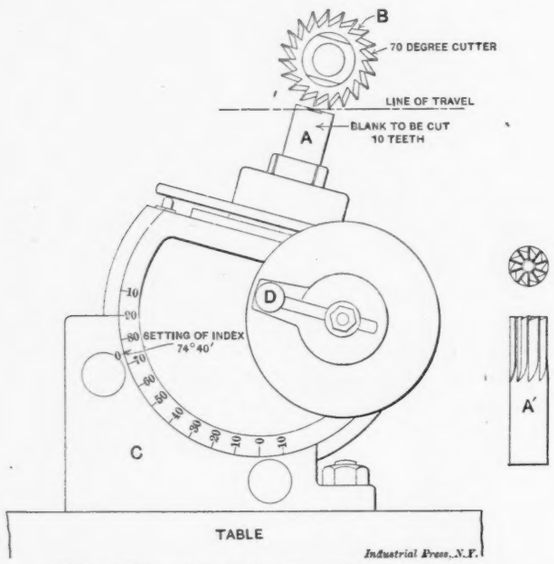
George G. Porter.

*Editor* MACHINERY:

In cutting the teeth on face and end mills the cut-and-try method is nearly always used in getting the index head set at the proper angle, and, indeed, most of the toolmakers and machinists know of no other way of doing it, but I have devised a very simple rule, and thinking perhaps the readers of MACHINERY would appreciate it, have arranged the following tables so that anyone who knows how to multiply can calculate the angle at which to set the head much quicker than by cutting and trying. And then, too, there is a certain satisfaction in being able to figure out a thing of this kind. The rule is:

*Multiply the tangent of the tooth angle by the contangent of the cutter angle, and the result is the cosine of the angle at which to set the head.*

The rule and use of the tables is best explained by an example. Suppose it is desired to cut a face mill with 29 teeth and we are to use a 70-degree cutter. Then looking in Table I. we find the tangent of the tooth angle to be .22012, and looking in Table II. we find the cotangent of the cutter angle (70 degrees) to be .36397; multiplying these two numbers together we get .08012, which is the cosine of the angle at which to set the head. Looking in Table III. for this number or the number nearest to it, we find it to be .08136, and the corresponding angle to be 85 degrees 20 minutes or 85 1-3 degrees. A sufficiently close result is obtained if we use the first three




Dividing Head set for Cutting End Mill having ten Teeth.

figures of the tangent and cotangent in Tables I. and II. respectively (of course increasing the third figure by one, if the fourth figure is five or more).

Perhaps for the benefit of the younger readers it will be well to work out one more example and from the data make a sketch showing the index head *C* in position on the table of the machine, and the cutter *B* on the arbor ready to take the first cut through the blank *A*.

Suppose we are to make an end mill with ten teeth and are to use a 70-degree cutter. Looking in Table I. we find the tangent of the tooth angle to be .727 (using first three figures), and from Table II. we find the cotangent of the cutter angle to be .364; multiplying these two numbers together we get .26354. In Table III. we find the number nearest to it to be .26443, and as this number (.26443) is opposite 74 degrees and in the column headed 40 minutes, 74 degrees 40 minutes is the angle at which to set the head. This angle is just a little less than 75 degrees, as will be seen by referring to the sketch.

In the sketch an end mill blank is shown as being held in a split collet, which is used to hold such mills when they are used in the spindle of the milling machine. At *A'* is shown the end mill as it is to look when finished.

* All rights reserved by Geo. G. Porter.

TABLE I. TOOTH ANGLES AND THEIR TANGENTS *

| Number of Teeth. | Angle. Deg. | Min. | Sec. | Tangent. | Number of Teeth. | Angle. Deg. | Min. | Sec. | Tangent. |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 72 | .... | ..... | 3.07768 | 31 | 11 | 36 | $46\frac{14}{31}$ | .20550 |
| 6 | 60 | .... | ..... | 1.73205 | 32 | 11 | 15 | ..... | .19891 |
| 7 | 51 | 25 | $42\frac{6}{7}$ | 1.25396 | 33 | 10 | 54 | $32\frac{8}{11}$ | .19273 |
| 8 | 45 | .... | ..... | 1.00000 | 34 | 10 | 35 | $17\frac{11}{17}$ | .18693 |
| 9 | 40 | .... | ..... | .83910 | 35 | 10 | 17 | $8\frac{4}{7}$ | .18147 |
| 10 | 36 | .... | ..... | .72654 | 36 | 10 | .... | ..... | .17633 |
| 11 | 32 | 43 | $38\frac{2}{11}$ | .64266 | 37 | 9 | 43 | $47\frac{1}{37}$ | .17147 |
| 12 | 30 | .... | ..... | .57735 | 38 | 9 | 28 | $25\frac{6}{19}$ | .16687 |
| 13 | 27 | 41 | $32\frac{4}{13}$ | .52484 | 39 | 9 | 13 | $50\frac{10}{13}$ | .16251 |
| 14 | 25 | 42 | $51\frac{3}{7}$ | .48158 | 40 | 9 | .... | ..... | .15838 |
| 15 | 24 | .... | ..... | .44523 | 41 | 8 | 46 | $49\frac{31}{41}$ | .15446 |
| 16 | 22 | 30 | ..... | .41421 | 42 | 8 | 34 | $17\frac{1}{4}$ | .15073 |
| 17 | 21 | 10 | $35\frac{5}{17}$ | .38740 | 43 | 8 | 22 | $19\frac{23}{43}$ | .14717 |
| 18 | 20 | .... | ..... | .36397 | 44 | 8 | 10 | $54\frac{6}{11}$ | .14378 |
| 19 | 18 | 56 | $50\frac{10}{19}$ | .34330 | 45 | 8 | .... | ..... | .14054 |
| 20 | 18 | .... | ..... | .32492 | 46 | 7 | 49 | $33\frac{31}{46}$ | .13745 |
| 21 | 17 | 8 | $34\frac{2}{3}$ | .30846 | 47 | 7 | 39 | $34\frac{32}{47}$ | .13449 |
| 22 | 16 | 21 | $49\frac{1}{11}$ | .29362 | 48 | 7 | 30 | ..... | .13165 |
| 23 | 15 | 39 | $7\frac{19}{23}$ | .28019 | 49 | 7 | 20 | $48\frac{8}{49}$ | .12893 |
| 24 | 15 | .... | ..... | .26795 | 50 | 7 | 12 | ..... | .12633 |
| 25 | 14 | 24 | ..... | .25676 | 52 | 6 | 55 | $23\frac{1}{13}$ | .12141 |
| 26 | 13 | 50 | $46\frac{2}{13}$ | .24648 | 54 | 6 | 40 | ..... | .11688 |
| 27 | 13 | 20 | ..... | .23700 | 56 | 6 | 25 | $42\frac{6}{7}$ | .11267 |
| 28 | 12 | 51 | $25\frac{5}{7}$ | .22824 | 58 | 6 | 12 | $24\frac{24}{29}$ | .10875 |
| 29 | 12 | 24 | $49\frac{19}{29}$ | .22012 | 60 | 6 | .... | ..... | .10510 |
| 30 | 12 | .... | .... | .21256 | ..... | .... | ..... | ..... | ..... |

TABLE II. CUTTER ANGLES AND THEIR COTANGENTS.*

| | 50° | 55° | 60° | 65° | 70° | 75° | 80° | 85° |
|---|---|---|---|---|---|---|---|---|
| Cotangent. | .83910 | .70021 | .57735 | .46631 | .36397 | .26795 | .17633 | .08749 |

TABLE III. COSINES.*

| Degrees. | Minutes. 0 | 10 | 20 | 30 | 40 | 50 |
|---|---|---|---|---|---|---|
| 60 | .50000 | .49748 | .49495 | .49242 | .48989 | .48735 |
| 61 | .48481 | .48226 | .47971 | .47716 | .47460 | .47204 |
| 62 | .46947 | .46690 | .46433 | .46175 | .45917 | .45658 |
| 63 | .45399 | .45140 | .44880 | .44620 | .44359 | .44098 |
| 64 | .43837 | .43575 | .43313 | .43051 | .42788 | .42525 |
| 65 | .42262 | .41998 | .41734 | .41469 | .41204 | .40939 |
| 66 | .40674 | .40408 | .40141 | .39875 | .39608 | .39341 |
| 67 | .39073 | .38805 | .38537 | .38268 | .37999 | .37730 |
| 68 | .37461 | .37191 | .36921 | .36650 | .36379 | .36108 |
| 69 | .35837 | .35565 | .35293 | .35021 | .34748 | .34475 |
| 70 | .34202 | .33929 | .33655 | .33381 | .33106 | .32832 |
| 71 | .32557 | .32282 | .32006 | .31730 | .31454 | .31178 |
| 72 | .30902 | .30625 | .30348 | .30071 | .29793 | .29515 |
| 73 | .29237 | .28959 | .28680 | .28402 | .28123 | .27843 |
| 74 | .27564 | .27284 | .27004 | .26724 | .26443 | .26163 |
| 75 | .25882 | .25601 | .25320 | .25038 | .24756 | .24474 |
| 76 | .24192 | .23910 | .23627 | .23345 | .23062 | .22778 |
| 77 | .22495 | .22212 | .21928 | .21644 | .21360 | .21076 |
| 78 | .20791 | .20507 | .20222 | .19937 | .19652 | .19366 |
| 79 | .19081 | .18795 | .18509 | .18224 | .17937 | .17651 |
| 80 | .17365 | .17078 | .16792 | .16505 | .16218 | .15931 |
| 81 | .15643 | .15356 | .15069 | .14781 | .14493 | .14205 |
| 82 | .13917 | .13629 | .13341 | .13053 | .12764 | .12476 |
| 83 | .12187 | .11898 | .11609 | .11320 | .11031 | .10742 |
| 84 | .10453 | .10164 | .09874 | .09585 | .09295 | .09005 |
| 85 | .08716 | .08426 | .08136 | .07846 | .07556 | .07266 |
| 86 | .06976 | .06685 | .06395 | .06105 | .05814 | .05524 |
| 87 | .05234 | .04943 | .04653 | .04362 | .04071 | .03781 |
| 88 | .03490 | .03199 | .02908 | .02618 | .02327 | .02036 |
| 89 | .01745 | .01454 | .01164 | .00873 | .00582 | .00291 |

*The tables given above are reproduced for the convenience of those readers who do not possess any one of the many handbooks containing such data. The angles whose tangents, cotangents and cosines are given, cover the range of all ordinary shop practice, but should other angles be wanted they may be found, of course in Haswell's, Kent's, Trautwine's, Suplee's or any other engineers' handbook containing tables of sines, tangents, etc. For use in the tool-room we shall doubtless publish the angular settings for mills of 5 teeth up, in a future data sheet.—EDITOR.

One looking at the sketch might be led to think that the teeth were cut on the end of the blank first, but such is not the usual practice, as it is more convenient to cut the side teeth first. The sketch was drawn this way to avoid confusion.

The line passing through the end mill blank in the sketch shows the line traveled by the points of the teeth of the 70-degree cutter. The line was so drawn to show how the teeth run out at the center of the blank but in actual practice the milling cutter is not set down to this line, as the spaces would be cut too deep, bringing the teeth of the end mill to a sharp edge, whereas they should have a narrow flat place left on top, called the land.

GEORGE G. PORTER.

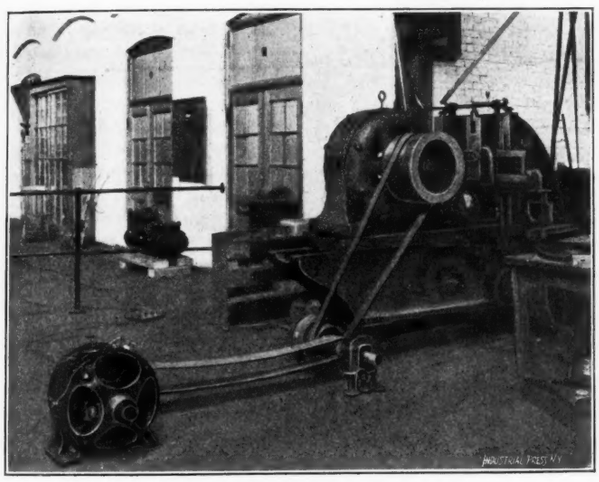
Syracuse, N. Y.

## TURNING A PULLEY ON A PLANER.

*Editor* MACHINERY:

The writer had occasion to true up a brake wheel or drum which was on the shaft of a 25-horsepower induction motor. This drum had to be exactly true, as it was to be used in testing the efficiency of the motor and ascertaining the brake horsepower. Our lathe was too small to swing it and it was impracticable to take out the armature shaft to send away. Accordingly it was "up to the writer" to devise some means for accomplishing the desired result, which was done in the following manner:

We placed the motor in question on the bed of a 24 inch by 24 inch planer, with the pulley face parallel with the cross-rail, clamping the motor to the platen in the usual manner for planing. A heavy tool was clamped in the tool-holder and allowed to extend above the top strap on the clapper tongue. To its side a lathe (turning) tool was clamped rigidly with



Turning a Pulley on a Planer.

the strap, before mentioned, as a support. To regulate the depth of cut, the table was advanced by turning the driving pulley on hand. Next a temporary jackshaft was rigged and placed, as shown in half-tone, which received its power from a 5-horsepower shunt-wound motor. It will be noticed that the belt from the driving motor is from a large to a smaller pulley; and also runs the other belt on the second size pulley on the jackshaft to the drum. This is the arrangement I used to file and polish after turning with tool. When the turning was being done I had the following hitch: From the pulley on the small motor (which is 6 x 6 inches) to the large pulley on the jackshaft (which is 12 x 4 inches) by a 4-inch belt, and thence from the smallest pulley on the jackshaft (4 x 4 inches) to the drum (12 x 18 inches) by a 2½-inch belt.

I used this arrangement to allow sufficient speed in the driving motor to gain power to do the work. Or, to put it more plainly, if the speed of the small motor was reduced enough to permit belting directly to the large drum for proper cutting speed—which result would be accomplished by putting a large resistance into the armature circuit—it would be found that the torque of the motor was almost destroyed. Therefore by allowing the motor to run at higher speed it developed greater torque, which was proportionally increased by the jackshaft and pulley arrangement. By actual measurement the field current was 230 volts and the armature current was 38 volts, additional resistance having been put in the armature circuit to reduce the speed.

As the belt was way over to the extreme edge of the drum, I turned it to size as far as possible and then changed the position of the drive by loosening the collar on the jackshaft and sliding it along till the belts would run on the opposite edge of drum. This job was done in an electrical engineering laboratory where every facility was easily obtainable.

Cambridge, Mass. HOWARD M. WEBBER.

## A SIMPLE CASE OF COMPOUND INDEXING.

Ralph E. Flanders.

*Editor* MACHINERY:

In cutting odd gears on a milling machine it is a common and annoying occurrence to find that the number of teeth desired, although not prime, is just beyond the range of the index plate. If the desired number of teeth is an even multiple of an indexing given in the table, say 2 or 3 or 5 times as large, a little knowledge of the principles of compound indexing will help one out of the difficulty. The method given here is simpler than that employed for prime numbers. A close approximation can always be obtained, and usually an exact indexing can be discovered.

Suppose we wish to cut a 96-tooth gear. This division is not given on the table, but we find that we can cut every other tooth by indexing for 48 teeth—15 holes in the 18 circle, as the table gives it. In this manner we cut around every other tooth in the whole circumference. Now the problem is to index the blanks such a distance that the cutter will halve the space between two adjacent cuts and make two perfect teeth. As soon as this is done, we may take 48 more cuts with the original indexing and thus complete the unfinished teeth.

To move the blank 1-48 of a revolution, or a distance of 2 teeth, take 15 holes in the 18 circle, or 15-18 of a turn of the index handle. To halve the tooth we must rotate the handle one-half of this amount, $\frac{1}{2} \times \frac{15}{18} = \frac{5}{12}$ of a revolution. The plate on the head is kept from turning by a pin which enters one of the holes in the outer or 20-hole row. If the plate be moved until the stop-pin enters the next adjacent hole, the worm has turned 1-20 of a revolution, while if we move the index pin 1 hole in its circle, the worm has turned 1-18 turn. The solution of the problem lies in finding a certain number of holes to move the plate past the stop-pin, which, combined with a suitable movement of the index-pin will give the required movement of 5-12 of a revolution to the blank.

A movement of the index-pin one hole gives 1-18 revolution to the worm. If the plate be moved one hole past the stop pin, the worm is moved 1-20 revolution. It is desired to move it 5-12 revolution; reduced to a common denominator these fractions become $\frac{10}{180}$, $\frac{9}{180}$ and $\frac{75}{180}$ respectively. By inspection of the numerators we readily see that:

$$\left(3 \times \frac{10}{180}\right) + \left(5 \times \frac{9}{180}\right) = \frac{75}{180}$$

In other words, a movement of 3 holes ahead of the index-pin in the 18 circle, followed by 5 holes with the stop-pin in the 20 circle, will, when added together, move the blank into position to index around the second time to cut the remaining 48 teeth.

Cases often occur in which it is impossible to get an absolutely accurate indexing by this method. Perhaps the following example will show a good way to obtain a close approximation in cases of this kind, and also make plain the method of allowing for whatever slight error there may be.

Supposing we wish to cut a gear with 63 teeth. On looking at our table we find that the best we can do is to cut 21 teeth, three times around. Start out to find the compound indexing the same as in the previous, remembering that we wish to find 1-3 of the regular indexing instead of ½. The indexing for 21 teeth is 40 holes in the 21 circle. On this plate the stop-pin enters one of the holes in the outer or 33 row. Reckoning as in the previous case, a movement of the index pin one hole will give the worm 1-21 revolution. Moving the plate one hole past the stop-pin will give the worm 1-33 revolution. We desire to give it 1-3 × 40-21 = 40-63 revolution. Reducing 1-21, 1-33 and 40-63 to a common denominator we have 33-693, 21-693 and 440-693 respectively.

We may try, if we wish, to find combinations of the first two fractions which added together will give the last, but a moment's thought will show that it is impossible. The numerators 33 and 21 are both multiples of 3, so all conceivable combinations of these numerators must of necessity be also multiples of 3. Inasmuch as the desired numerator, 440, is not divisible by 3, we must evidently content ourselves with an approximate solution. If we say that 441-673 revolution of the worm is near enough for our purpose, a little figuring will show us that (7 × 33-693) + (10 × 21-693) = 441-693, or in other words, 7 holes ahead with the index pin in the 21 circle, followed by 10 holes ahead of the plate past the stop-pin, will approximately divide our indexing into thirds, and bring our cutter into position to cut another set of 21 teeth around.

It is practicable to make allowance for the error we have introduced into our calculations. The indexing worked out above will revolve the worm 441-693 of a turn. As we found the correct amount to be 440-693, this approximation carries the worm 1-693 of a revolution too far. As the worm moves 40 revolutions to 1 of the wormwheel, the blank has been turned $\frac{1}{693 \times 40} = \frac{1}{27{,}720}$ revolution too far. Suppose we are cutting a 10-pitch gear. Then the pitch diameter for a 63-tooth gear is 6.3 inches, and the pitch circumference is 6.3 × 3.1416 = 19.72 inches, about. The blank was found to be turned $\frac{1}{27{,}720}$ revolution too far; therefore, it has gone on the pitch circle $\frac{19.72}{27{,}720}$ = .00071 inch too far. If now the saddle of the milling machine be moved along the knee to bring the blank back past the cutter about .0007 after each compound indexing, we may preserve the proper thickness of tooth all the way around. The cutter had best be re-centered after every two or three gears, as this movement, if made often enough, will finally throw the cutter too far to one side.

In hunting for combinations of compound indexing, and other work of this kind, a person whose mind takes naturally to mathematics will discover rules and ways of working, which will change the search from a blind hunt to a systematic one, thus saving considerable time and worry.

When this method of indexing can be used, the reduction in the number of double indexings, and consequently, in the number of chances for mistakes, gives it an appreciable advantage over the strictly compound method.

Nashua, N. H. R. E. FLANDERS.

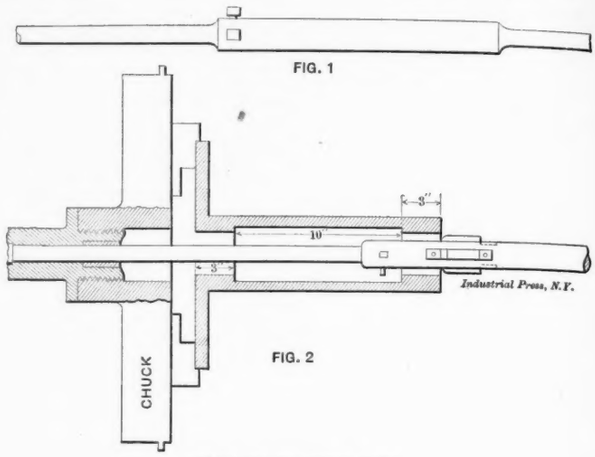
* * *

## BORING BAR FOR CHUCK WORK.

*Editor* MACHINERY:

The accompanying sketches show a boring bar for boring long holes in pieces chucked in an ordinary hollow spindle lathe. The sizes and length of the bar are governed by the diameter and length of the hole to be bored. One end of the bar is flattened to fit the tool post, and the other is supported by a bushing in the lathe spindle. The flattened end should have its center that was used in turning left in, so that it can be properly lined up when clamped in the tool post by using the tailstock center. It will be observed that the tool cannot be fed into the work by using the cross slide, as this must remain stationary or it will result in a tapered hole.

In boring holes, as shown in Fig. 2, a reamer can be built on the bar just back of the cutter, but must be far enough back to allow the cutter to pass through into the large cored part before the reamer enters. By referring to the




Boring-bar for Chuck Work.

sketch it will be seen that there is room between the end of the lathe spindle and the work for the cutting tool while the reamer is reaming back side of hub. C. P. L.

## THE ETERNAL QUESTION.

Cornell Ridderhof.

*Editor* MACHINERY:

"Frank, how many thirty-seconds are there in an inch?"

Frank took a steel rule and with the aid of his finger-nail succeeded in finding thirty-three!

This young man had "worked at the trade" about eighteen months before he came to us. We had him doing rough lathe work and the like, and on easy work that meant little more than the repetition of a series of movements, he did fairly well, considering—yes, considering that he could not think. Of course Frank was not paid as much as he thought his labor was worth, so felt that he was doing us a favor by working for us, and when one day a job was given him which he considered beneath his dignity to do, he promptly refused and was as promptly dismissed.

More than one young man has come into and left our shop in the same manner. By chance they are brought into a machine shop, as they have been advised to learn a trade and thinking the machinist's trade as good as any, they will just learn that. They learn it like a monkey learns to strike matches—by mere imitation. Now intelligent imitation is a good thing; it is *necessary*. Were it possible to stop it there could be no progress; but the mere mechanical imitation of what we see others do, without knowing, nor caring to know the why and wherefore, renders a human being a mere automaton—a piece of machinery.

I hear some one remark: "That boy might have done real well at some other trade," with which I do not agree. I do not happen to be sufficient of a jack-of-all-trades to be acquainted with many but I have yet to hear of a trade in which a man who cannot think can be successful. As in machinist's work, there are some operations in other trades he might learn to do, as before stated, like an automaton, but he no more will know that trade than a phonograph with a French record on it knows French.

It must be true that many men are "cut out" for certain work and yet there is a whole lot of truth in it that a man who is successful in one line of work, should he give all his energy to it, would be successful in another. Only it means good hard work in the right direction and right where one is.

Not what "we would do if we only were in such or such a place," but as Bob Fitzsimmons said, "hit from where your hand is." Failing to appreciate the value of doing the best they can *anywhere* is a fault common to the boys. They can't sweep the floor well before they want to get on a machine; before they can drill a hole where it is wanted they "want to get on a lathe," and so on. And then, on any machine, they want to pick out their own jobs (a "snap" usually) and vise work is despised as if it were degrading.

Perhaps the reader expects me to suggest a remedy. Most of us are ready with advice, but it is too often of the kind that was given the driver of a balky horse: "Just get 'er started and she'll go." But they don't tell how to "get 'er started." So with the boys. Get them to see that they cannot float upstream, nor slide down to the top of the ladder; that they must work, not only with their hands but as well with the small part of their brain that is awake, and once this is started the rest of the gray matter will be aroused and it will surprise all to see what they are capable of doing when aroused out of their lethargy. It is easy to give advice like this, but not so easy to follow it. I have tried it and sometimes with a degree of success, but the thought that only the more willing, energetic ones responded robbed me of all self-conceit.

CORNEIL RIDDERHOF.

Grand Rapids, Mich.

Wanted—Opportunity to learn the trade of blacksmith, machinist or carpenter. ——— ———, Vernon, Vt.

The young man who inserted the above "ad." in a Vermont paper a few weeks ago evidently does not feel quite sure what he was "cut out" for, but is willing to take a "whack" at any old trade. Perhaps he has expressed his preference in the order given, and, as Mr. Ridderhof intimates, if he does with his might what his hand is set to do he will win a certain degree of success in any one of the three trades. Nevertheless it seems too bad to make an indifferent carpenter out of a good blacksmith—or preacher. There is a vast difference between a mere inclination and a deep-seated instinct. The boy who has the mechanical instinct thinks "wheels," or constructive work of some kind. The fact remains, however, that to achieve success in any calling, mechanical or other, a degree of mental activity is required that impels a man to go ahead on his own initiative and not always wait to be told.—EDITOR.]

* * *

## MACHINING A SEWING MACHINE "CROSS-HEAD CAM."

*Editor* MACHINERY:

In the accompanying illustration, Fig. 1, are shown top and side views of a small casting *A* with a milled cam slot *B* on one side, and the hub *C* on the other side, through which runs a hole *D*. There is also a lug *E* with a hole *F*. It is used in a certain type of a sewing machine, and is termed "crosshead cam." It is machined on the front, being faced off straight. The three sides of the cam slot *B* are milled out, and the holes *D* and *F* are drilled and reamed true to the

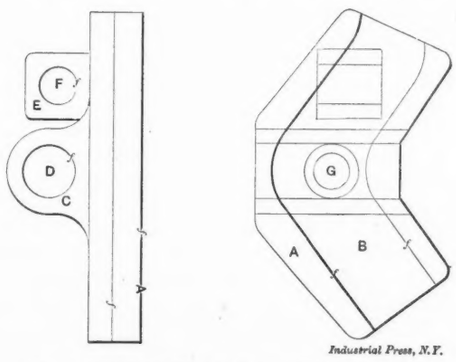



Fig. 1. Crosshead Cam to be Machined—Full Size.

cam slot. As the building of this type of sewing machine was a "special order," the market demand for which was uncertain, temporary tools had to be designed and made for it. By this is not meant tools of elaborate and expensive designs that will manufacture the goods at a minimum of cost, but tools that are quickly designed and made at no great cost and will produce the goods at a reasonable cost for manufacturing.

Figs. 2, 3, 4, 5, and 6 are the tools designed and made for the purpose. The first operation on the crosshead is the facing of face *A*. Fig. 2 shows top and side views of the

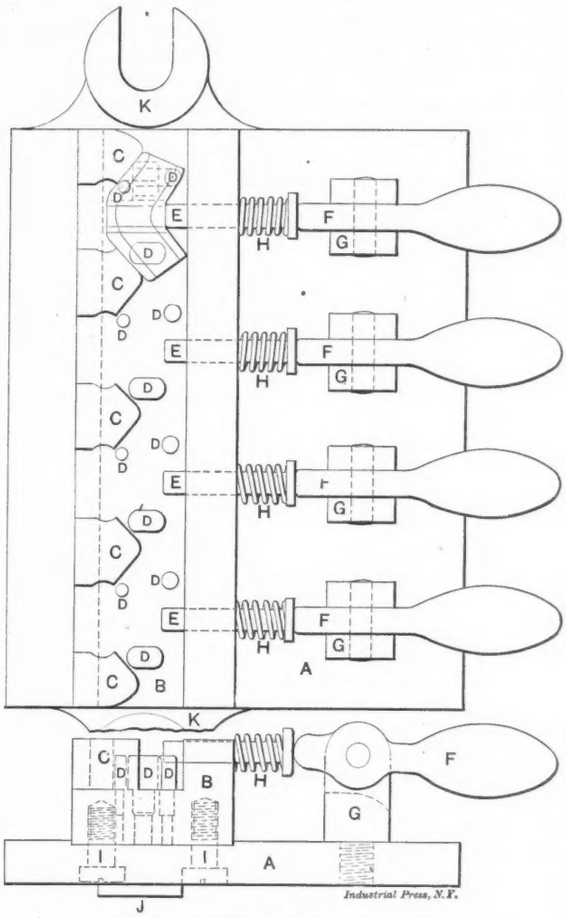



Fig. 2. Jig Holding four Cams for Planing.

fixture in which that operation is performed on four crossheads at one time. The fixture sits on the table of the milling machine with its tongue *J* fitting in the corresponding slot in the table; the body *A* is fastened with clamps and screws to

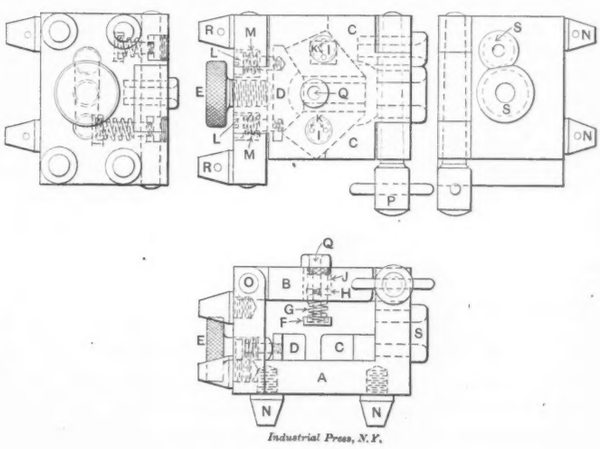



Fig. 3. Drilling Jig.

the table. The crosshead castings Fig. 1 to be faced, fit in the fixture, Fig. 2, between *C C*, whose recessed angles correspond to the sides of the crosshead, and they rest on three supporting pins *D, D, D*. The fastening is done by the handle lever *F* being moved upward, thereby forcing the plunger *E* inwardly against the crosshead and fastening it between *C, C,* and *E*. A slight tap with a mallet on the face of the castings

forces them down solidly on the top of the pins, and the four castings are easily and smoothly milled on their faces by a spiral-fluted cutter, when they are easily removed by pressing the handles *F* downward, thereby allowing the plungers *E*, actuated by springs, *H*, to move out and release the crossheads.

The next operation is the drilling of the holes *D* and *F*, and is done in the drill jig, Fig. 3. The taper pin *P* is withdrawn from the body A, and the lid or cover *B* that hinges on pin *O* is swung back, allowing the crosshead to be put in place with its milled face against the bottom of the jig and its sides against the sides of the steel piece *C*, *C*. The lid or cover *B* is then swung back in place and fastened by the insertion of taper pin *P*. It will be noted that under the cover *B* there are projecting two small plungers *F*, *F*, of about the shape of screws with large heads. The heads are recessed for the reception of springs *G* which give the plungers a downward tension. The bodies of the screws fit loosely in holes in the cover and have small round nuts *H* screwed on their ends to secure them from dropping out. The recesses *J* in the cover allow room for the up-and-down motion of the plungers, and the stop plugs *I*, which are screwed in the top of cover *B* with a little pin-wrench engaging the holes *K*, prevent the recesses *J* from getting clogged with dirt. When the lid *B* is turned back to its place and fastened by pin *P*, with the crosshead casting inside of the jig, the two heads *F*, *F* of the plungers pin down the crosshead on its face against the flat bottom of the jig. Then by the turning of the knob of screw *E* the steel piece *D* is moved forward and its side pressed against the sides of crosshead, gripping it tight between its faces and opposite faces *C*, *C*. The hole *G* in the crosshead is then drilled through the bushing *Q* when the drill jig rests on the legs *N*, and the holes *D* and *F* are drilled through the bushings *S S* while the jig rests on the legs *R*, *R*.

When the screw knob *E* is turned back the steel piece *D*, actuated by springs *M* on screws *L*, moves back, releasing the crosshead. The pin *P* is withdrawn, the lid *B* thrown back and the crosshead removed. It is then held between a wooden clamp and the holes are slightly reamed to insure uniformity in size of the holes *D* and *F*.

The casting is then ready for the milling of its cam groove *B*, which is done in a profiling machine, and is held in a fixture, like Fig. 4. This is a vise-like arrangement made entirely of steel. The body *A* has a jaw-like head *B*, *B*. A slide *C* attached to the body with two gibs *D* and screws *E* is moved by the screw *H*, fitting in recess *G*, and the threaded nut *O*. The crosshead, while it fits and is clamped between jaws *B*, *B* and *F*, first rests on and is lined up by the pins or plugs *M*, *L*, *I* and *K* in the fixture, to insure the milling of groove *B* in the crosshead being true with holes *D* and *F* and the face *A* in the crosshead. The desired result is attained by the pins *M* and *L* fitting nicely in the head *B* of the fixture, in the holes *D* and *F* of the crosshead, and in the corresponding holes in the slide *C*, and being parallel to the bottom of the fixture. This insures the true alignment of the crosshead. The vertical pin, *I*, fitting loosely in the hole in the fixture and resting on the taper part *J* of pin *K*, is for the purpose of providing a support to the body of the crosshead, against which it is pushed up gently, by turning the knurled end of pin *K*, purposely made of a small diameter for preventing the exertion of too much pressure and thereby springing the side of the crosshead upward, instead of merely providing a support for it when it is fastened between the jaws *B*, *B* and *F*.

The body of the fixture is fastened to the bed of the profiling machine with straps and screws, and the milling of the grooved cam is done by a spiral cutter fastened in one of the holders of the head of the profiler, while a pin like Fig. 6 is fastened in the other holder of the head, the end fitting nicely in a corresponding groove exactly like the one to be milled and a little longer at the ends. The groove is made in a steel fixture like Fig. 5, which acts as a guide for the motion of the profiler head holding the milling cutter that mills the cam groove in the crosshead Fig 1. In order to insure uniformity in the width of the grooves, and a smooth finish, the work had to be gone over twice with the cutter, which, however, was done quickly, as the cutter was run at high speed.

Newark, N. J. H. ROBINSON.

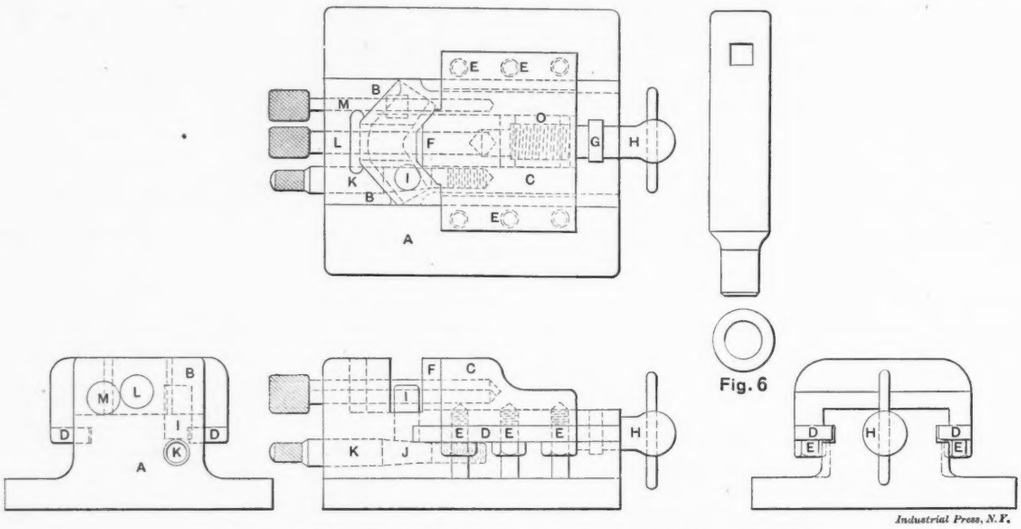



Fig. 4. Jig for Milling Cam Slot.

Fig. 6. Guide Pin.

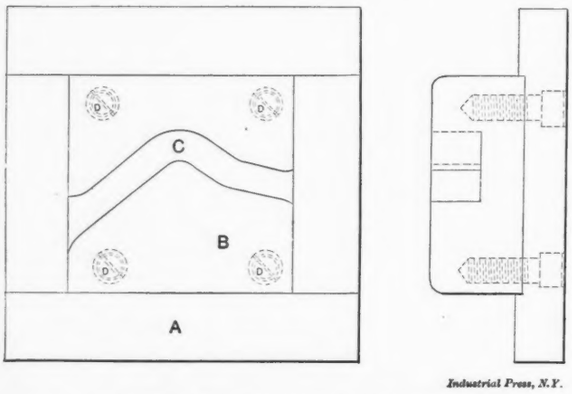



Fig. 5. Master Cam or Guide Plate for Profiling Cam.

* * *

The owner of an extensive woodland tract in the Adirondacks has installed a steam wood-chopper for economically working timber valueless for lumber into small blocks for fuel. It takes whole trees, butt end foremost, and reduces them to blocks, splinters and shavings in short order. How many a farmer boy has sighed for something on this order to relieve him from the back-breaking bucksaw!

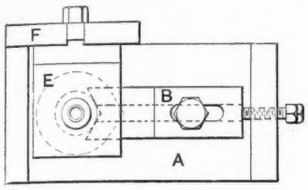
# SHOP KINKS.

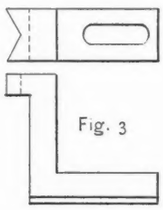
**A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.**

**Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.**

## SIMPLE DRILL JIG.

The simple drilling jig shown herewith is in use at the W. F. & John Barnes shops, Rockford, Ill., and is adjustable so as to be adapted to pieces of different shapes and dimensions. The base piece *A* supports an upright *F*, to which the knee, *E*, is bolted. This knee is for the drill bushing and is tongued and grooved to the upright so that it may be raised or lowered for work of different heights. The work is held



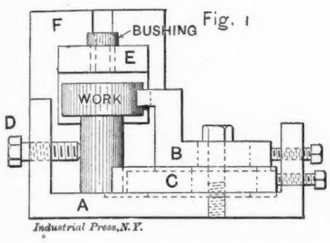




Fig. 1

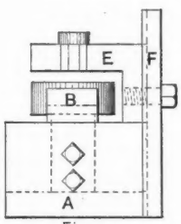
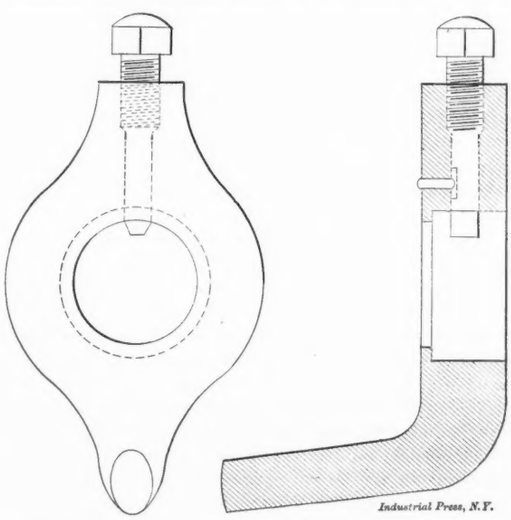



Fig. 2

by two slides, *B* and *C*, and a setscrew *D*. The lower slide, *C*, has a tongue fitting in a groove in the base and one end is V-shaped to give support to the lower end of the work, against which it is made to bear. The slide, *B*, has a tongue fitting in a groove in the top of the lower slide, and may thus be adjusted independently of the latter.

## STUD GEAR DOG.

I send sketch of a stud gear dog that I have used in the shop for several years. The dog is used on the pinions cut on the ends of shafts and I use four on my job here. The hole for the pinion is bored to the same diameter as the outside diameter of the pinion but it is not bored clear through,




a shoulder being left, as shown. The hole for the setscrew is drilled as usual, but is tapped only about half way through. A pin is turned to fit and its inner end is beveled to fit the tooth space of the pinion. The pin is kept from falling out by a screw or pin engaging a short keyway cut in its side.

Nashua, N. H. A. A. LAURIAN.

## DOG FOR HANDLING PLATES.

W. H. S. sends us a sketch of a dog which has been tried and found very successful for lifting cast iron plates of 150 to 200 pounds weight, and which may be attached to a trolley for moving the plates about. The load is held by friction and is released instantly when the plate is lowered to the floor. The jaws *E E* are lined with sole-leather, riveted on. In spite of the law which says that friction is dependent upon the pressure regardless of the area, it has been found best to make these jaws about 2 x 3 inches square, the reason being that the roughness of the castings cuts into the leather somewhat, affording a mechanical grip in addition to the friction. The arms *B* should be continued down, as shown at *D*, Fig. 2, so that the jaws *E* will not drop down out of position when the load is released.

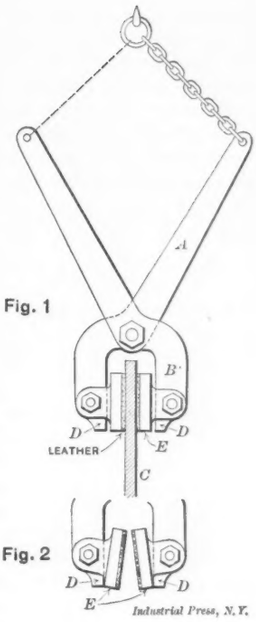
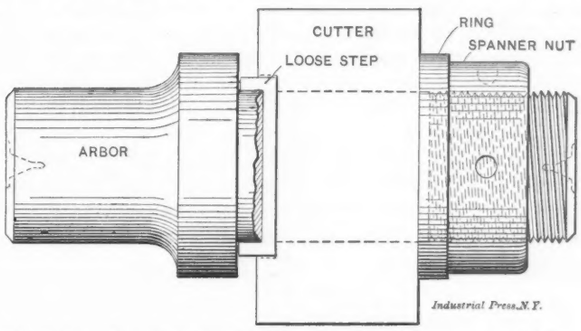



Fig. 1

Fig. 2

## ARBOR FOR TURNING AND GRINDING BORING CUTTERS.

I have read in your journal descriptions of several shop kinks which we have found interesting and useful, and I have one that I wish to introduce to the readers. It is an arbor for turning and grinding boring cutters to exact size. The




arbor is made of steel with deep hardened centers and has a slot to accommodate cutters of any size and diameter within limits. It is provided with a number of loose-fitting steps to suit the cutters from different boring bars. Between the cutter and the spanner nut holding it, is a steel ring or washer faced true on both sides so as to hold the cutter squarely in the arbor slot. This arbor is used by the New York Shipbuilding Co., Camden, N. J., and has been found to be an improvement over the old method of making and grinding boring cutters. H. G. NORDBY.

Merchantville, N. J.

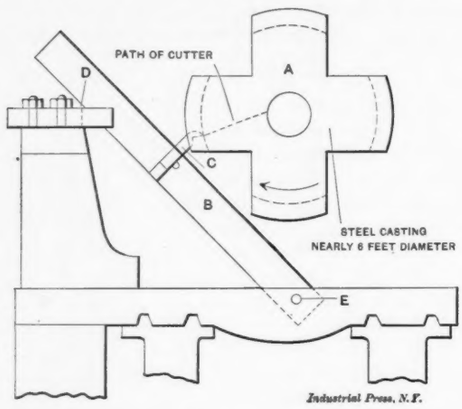
## GRINDING A TAP TO CUT OVERSIZE.

Several years ago while employed in a shop that used a large number of studs we accumulated a kegful that were too large in diameter on the short thread end. Not having a tap large enough, they were rejected, but before we could get others there came a hurry job on which we had to use about sixty of the studs. The old trick of using a tin liner beside the tap made the hole too large, and wrapping the tap with waste did not make it large enough. In looking around for a way out of the difficulty I found an old stud tap that was very dull. It was no larger than the other taps, but after sharpening two adjacent lands of teeth, that is, sharpening the teeth of lands Nos. 1 and 2, leaving lands Nos. 3 and 4 dull, the tap worked to perfection, tapping the holes oversize just the desired amount. This may be an old trick, but I had never heard of it before, nor have I ever seen it used since. JOHN A. BURGESS.

Elmira, N. Y.

### CUTTING-OFF TOOL USED ON SIX-FOOT STEEL CASTING

Cutting a steel casting, nearly six feet in diameter, in two in the lathe is a quite extraordinary job. The *Electric Club Journal* describes how a steel casting for a turbo-generator revolving field of this size was cut through in the middle. A special tool was rigged for the purpose and consisted of the ½-inch steel bar *B* carrying a cutter *C*. The bar was pivoted to the lathe carriage at the lower end at *E*, and the upper end rested against the inner edge of the tool rest from which,

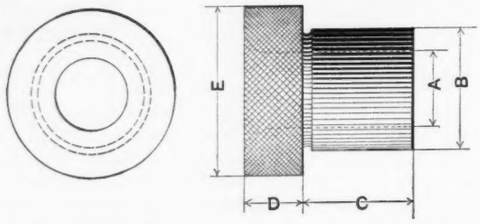



of course, the feed was taken. The cutter *C* was firmly keyed in the bar and moved toward the center of the casting in an arc of a circle, as the cross-slide fed inward. The casting *A* was mounted on a mandrel, and was rotated backward, thus requiring the tool to face downward. The reason for this was to prevent the chips crowding and interfering with the action of the tool. The cutter face was, of course, slightly wider than the bar so that the latter could follow into the cut as the center was approached.

* * *

## DIMENSIONS FOR STANDARD JIG BUSHINGS.

In the design of drill jigs there is little save experience and judgment to guide the draftsman when determining the dimensions of the drill bushings. This often results in having bushings for the same size of drill, made with widely varying




dimensions as to length and outside diameters. If, on the other hand, some standard is adopted and adhered to, uniformity will be insured and the toolmaker can make up bushings in leisure moments, knowing that they will be available whenever a rush job of jig work comes along. "E. W. D." has contributed the two accompanying tables of dimensions of bushings, which are now in use by a large manufacturing concern and furnish an excellent guide for any draftsman designing jigs where no standard has been adopted.

Table 1 gives dimensions for bushings which are to remain in the jigs permanently and in making these bushings the external diameter given in the column B would be made a driving fit in the hole in the jig. Table 2 gives dimensions for removable bushings and in this case the outside diameter would be made a light sliding fit in the hole. In both tables the column *A* indicates the size of drill for which the bushing is to be used and would be made from .003 to .005 inch larger than nominal size.

TABLE 1. DIMENSIONS FOR STANDARD FIXED JIG BUSHINGS.

| Size Drill. A | B | C | | | D | E |
|---|---|---|---|---|---|---|
| | | Short. | Med. | Long. | | |
| 60 | | | | | | |
| | | | | | | |
| | | | | | | |
|

## HOW AND WHY.

**A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.**

**Give all details and name and address. The latter are for our own convenience and will not be published.**

22. B. E. L.: We have some difficult jobs at times which no doubt would interest others. Do you charge for publishing anything of this kind?

A.—No charge whatever is made for publishing matter that appears in the reading columns of MACHINERY; on the contrary, we *pay* for all accepted contributions. We might add that where special photographs are required or it is necessary for the contributor to incur other expenses, we are quite willing to remunerate him additionally for same. Under such conditions previous arrangement should be made with us.

23. E. S.—What is the best chemical preparation to use for brushing axes, hatchets, etc., immediately after they have been hardened and then put against the fire to be tempered? The object of applying a preparation is to make the surface of the steel clean enough so that the color is visible as the temper is drawn.

A. Probably some reader of the paper can give you more information upon this than can we, but we would suggest the use of hydrochloric acid—in the proportion of about 1 to 20—such as is used in freeing boiler plates, or other rolled metal, from scale.

24. O. P. L.—What are the specific heat and the specific gravity of mineral cylinder oil, 600 degrees F. test?

A.—We are not able to supply the information desired, and refer this inquiry to our readers. The question was referred to Prof. R. C. Carpenter, of Cornell University, who states that while they have conducted some experiments on the specific gravity of oils, these experiments have not extended beyond those of 450 degrees F. test. They have not determined the specific heat of any of the oils. Prof. Carpenter adds that there are very few oils indeed that can be heated as high as 600 degrees F., the flash point of the best cylinder oils being about 550 degrees F.

25. G. H. R.: If the valves of a double reversing engine be correctly set with 1-32 inch lead and it is found that the link-block just strikes the end of the link when hooked in the backward motion, and in the forward motion there is ⅜ inch clearance, will it alter the lead if I equalize the throw of the link-block by shortening or lengthening the link hangers?

A.—The lead will be changed so little that you will scarcely notice it, but the best way to equalize the throw of the link-block is to lengthen or shorten the reach-rod connecting the reverse-lever with the tumbling-shaft. If the reverse-lever is directly attached to the tumbling-shaft, shift the sector rack or quadrant so the position of the links will be equalized. If you change the length of the link hangers it will probably affect the steam distribution somewhat and for that reason is unadvisable.

26. A. M.—I would like some reliable information upon the sizes of standard pipe taps at the small end.

A.—There is no standard followed by manufacturers of taps for the small end of pipe taps. By referring to Kent's Mechanical Engineer's Pocketbook you will find, under the heading "Wrought-iron Pipe," tables giving the exact dimensions of the taper threaded end of pipes of different diameters, which is in accordance with Briggs' standard; and this would be the *theoretical* size of the pipe tap also. *Practically*, however, the tap is made longer than this tapered portion. The small end of the tap would be somewhat smaller than the small end of the tapered portion of the pipe. One manufacturer, to whom we have referred this question, says it is their custom to continue the tap three or four threads beyond the theoretical smallest diameter, as given by Briggs' standard.

27. C. S.—Please explain the effect upon the speed of an engine, of increasing the weight of the governor balls. Is the effect the same with the inertia, pendulum and centrifugal governors?

Answered by F. H. Burton.

A.—In general, increasing the weights of any shaft governor makes the engine run slower; as, with the spring tension remaining the same, the heavier weight gives the centrifugal force required to balance the spring tension at a slower speed than lighter weight. This applies more particularly to a double-weight shaft governor. With a single-weight governor of the inertia type, adding weight to what may be called the heavy end will cause the engine to run slower for the reason given above. Adding weight to the light end will cause the engine to run faster, as this weight, in a general way, balances the heavy end.

28. J. A. C.—A 36-tooth, 12-pitch spur gear is required to mesh with an internal gear of 42 teeth, 12 pitch. Will the Brown & Sharpe regular spur gear cutter allow these gears to properly mesh, or will it require cutters of special form? and if so, why?

A.—Mr. Oscar J. Beale, of the Brown & Sharpe Mfg. Co., has replied to this inquiry, and we have asked him to contribute an article upon the subject of internal gearing which we hope may appear in the near future. Mr. Beale writes:

"A 36-tooth spur gear cut with a B. & S. regular cutter will not mesh correctly with an internal gear of 42 teeth. A spur gear running into an internal, develops epicycloid curves, and these curves interfere with ordinary involute teeth. In other words, a spur-gear tooth must have room to develop its own epicycloidal curves, inasmuch as it is solid and is in the way of any other solid that is on its own side of the developed curve.

29. L. W.—Does the momentum of a flywheel vary as its weight and velocity, or does the momentum more than double, say, by doubling the velocity, the weight remaining the same?

A.—The momentum of a moving body is its mass multiplied by its velocity, or $mv$. The mass of a body is its weight divided by 32.2 (a constant expressing the acceleration produced by gravity in a freely falling body in one second). Hence

$$M = \frac{w\,v}{32.2}$$ in which

$M$ = momentum
$w$ = weight
$v$ = velocity (in feet per second).

But the *energy* of a moving body is expressed by the formula:

$E = \frac{1}{2}\ mv^2$ in which

$E$ = energy
$m$ = mass (weight divided by 32.2)
$v$ = velocity.

Hence it follows that the momentum of a flywheel, or other moving body, varies directly as the velocity, but the kinetic energy (which makes a flywheel valuable as a power reservoir) varies as the square of its velocity.

30. E. L. W.—Please tell me how to make a flux for brazing sheet brass into linings, for brass-lined cylinder work. It is desirable to have the flux melt at as low a temperature as possible, and to leave the inside of the lining as free from rough spots as possible in order not to cut the plunger packing.

A.—We referred this to the American Gas Furnace Co., Elizabeth, N. J., who reply as follows. 1. The cylinder must be so formed that the hub joint comes together tight, both ends of the joint being true, so they will come together and touch along the whole length. 2. Dissolve powdered borax in water, so as to make a thin paste and mix with ordinary brass solder such as is ordinarily used for brazing brass. 3. Apply the dissolved borax *only* to the seam with a brush. 4. Cover the seam with the wet brass solder—a thin layer covering the joint. 5. Braze in a gas furnace, in either of two ways: A. Apply solder on the inside, and braze in a horizontal position, seam down, sliding the cylinder along over a good burner, directed upon the seam from below. B. Braze by flame from the top, seam up, solder applied on the outside.

The company add that if any of our interested readers will send them a cylinder ready for brazing they will do it with pleasure and report on the proper furnace to be used.

31. Apprentice: I often hear our toolmaker speak of different grades of steel as "fifty-point-carbon," seventy-point-carbon," etc. What do these terms mean?

A.—The suitability of steel for most mechanical purposes is determined by the percentage of carbon it contains; in almost all cases it is less than one per cent. and is expressed in decimals of one per cent. Thus "fifty-point-carbon" means that the steel contains 0.50 per cent., or one-half of one per cent. carbon. In other words in every one hundred parts one-half part is carbon. It is awkward to say "fifty-one-hundredths of one per cent. carbon," so the nomenclature by common consent has been shortened to that given above.

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32. A. R. B.—What is the change of weight of a volume of water, say 1 cubic foot, from 32 degrees F. to 212 degrees? 2. To what degree can water be compressed?

A.—The weight of water varies slightly with its temperature. At 32 degrees F. a cubic foot of pure distilled water weighs 62.417 pounds; at 39.2 degrees (temperature of greatest density), 62.425 pounds; at 100 degrees, 62 pounds; and at 212 degrees, 59.84 pounds. The volume corresponding to the change of temperature can be found very closely, according to Goodman, by the following empirical formula:

Volume at absolute temperature. $T$, taking the volume at 39.2 degrees $= \dfrac{T^2 + 250{,}000}{1{,}000\ T}$

F. or 500 degrees absolute as 1

Thus the volume at 50 degrees $=$

$$\frac{(461 + 50)^2 + 250{,}000}{1000 \times 511} = 1.0002368$$

Hence the weight of 1 cubic foot of water at 50 degrees would be 62.425 ÷ 1.0002368 = 62.41 pounds. 2. Water is slightly compressible, a pressure of 3,000 pounds per square inch reducing its volume about 1 per cent. The approximate formula by which the reduction in volume may be calculated, within limits, is as follows:

$v = \dfrac{p\,V}{K}$ in which

$v$ = diminution in volume, in per cent.

$V$ = original volume.

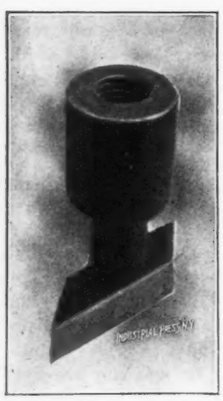
$K$ = modulus of elasticity, taken to be 300,000 to 320,000 pounds per square inch.

* * *

The piston blowing engine as applied to blast furnaces for the production of pig iron, was first used at the Carron Iron Works in England about 1760. Previous to this date huge bellows operated by hand, animal or water power, had been used. The Carron Iron Works blowing engine was driven by water power.

* * *

## A STUD T-HEAD BOLT.



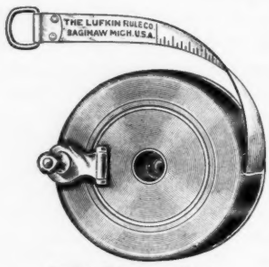
Lang T-head.

Below is reproduced the photograph of a T-head bolt which is intended to be a time-saver. It is drop-forged and case-hardened, and by reference to the cut it will be seen that the head is so shaped as to fill the T-slot, when given a half turn, and not slip. Where these heads are used for clamping work on machines it is only necessary to thread up any number of studs of any length in the bolt cutter and screw one end into the T-heads, the other end being threaded for the nut as usual. These heads are made of different sizes to fit all standard machines and are tapped for bolts ranging from ½-inch to 1⅛ inches in diameter. They are made by the G. R. Lang Co., Cincinnati, Ohio.

* * *

## STEEL TAPES FOR MEASURING CIRCLES.

It frequently occurs that the easiest way to find the diameter of a pulley, drum, flywheel, tank or other circular object, is to pass a tape *around* it, measure the circumference and determine the diameter by dividing the circumference by the constant 3.1416. But if the tape were graduated so as to indicate diameters when measuring circumferences, there would be an obvious gain of time and convenience, to say nothing of eliminating the chance for error in calculation. To meet this want the Lufkin Rule Co., Saginaw, Mich., have brought out one style of their "Artisan" steel tapes which is graduated on one side in consecutive inches and 16ths and in diameter divisions on the opposite side. With this tape it is asserted that it is possible to measure within 1-64th inch of the actual diameters of pulleys, shafting, etc., by simply measuring the circumference. The tape is made of the best quality of steel, ⅜-inch wide, and is heavy enough to stand hard service. The case is nickel-plated and has flush handle for winding the tape into the case.




Lufkin Diameter Tape.

* * *

## SIMPLICITY OF MOTOR DRIVE FOR MULTIPLE SPINDLE DRILL.

The Pratt & Whitney multiple spindle drill shown herewith has recently been equipped with individual motor drive, for use in the factory of the Emerson Electric Mfg. Co., St. Louis, Mo. It will be seen by the photograph that this makes a compact and simple arrangement. The tool was stripped of all countershafts, pulleys, etc., and a ½ horse power vertical Emerson motor securely mounted on the frame. A Renold silent chain drive is used for connecting the motor and drill spindles. These latter are equipped with ball bearings, which seemed advisable to reduce the amount of power required and to decrease the wear on the universal joints. This equipment enables the operator to turn out better and more work than before, the machine being much steadier. The company add that it is often a surprise to machine tool users and manufacturers to find how large a number of pulleys, belts, etc., can be dispensed with, even on small machines of this character, when motor drive is used. Fig. 2 shows the parts which were removed from this tool, for which the motor was substituted.

Fig. 1. Multiple Spindle Drill with Motor Drive

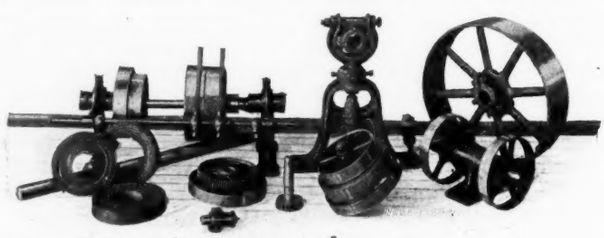


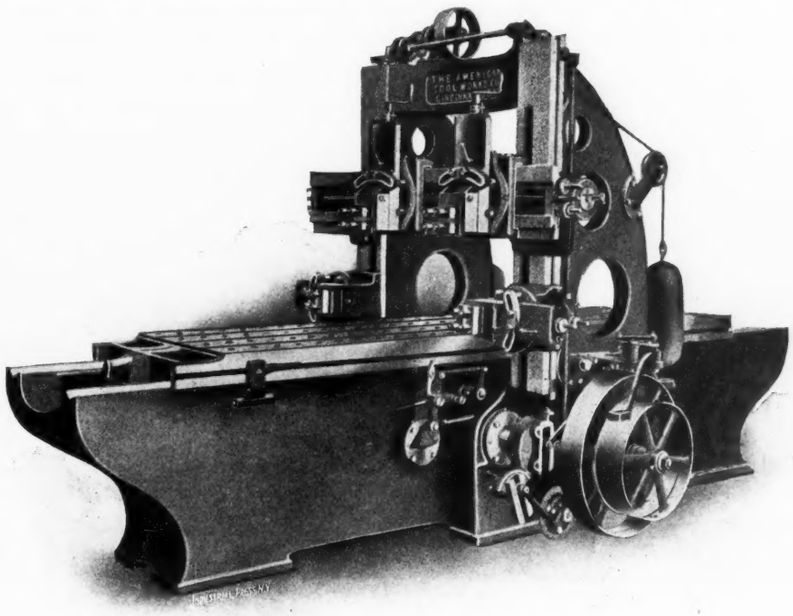
Fig. 2. Countershaft, Pulleys, Belts, etc., displaced by Motor Drive.

# NEW TOOLS OF THE MONTH.

## A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

### IMPROVED METAL PLANER.

This machine has been built in order to meet the demand for a planer that will successfully resist the increased strains to which the modern methods of shop practice subject it. The bed is very deep, extending almost to the floor line, and has substantial legs cast integral with it. Heavy box cross girts at short distances give rigidity to the bed. The central portion where the strain is heaviest is strongly re-enforced.



American Tool Works Company's Planer.

The table is of ample proportions, well braced by ribs, and is equipped with an improved dirt-proof feature; it also has quick return, reversing without shock or jar. The shifting mechanism removes the belt from one pulley before the other is engaged, obviating shrieking of belts.

The feeds are automatic in all directions and can be operated from either side of the machine. Side heads can be furnished, as shown in the illustration, or fitted after the machine is built, with slight modifications. The slides are so constructed as to permit planing at some distance from the housing. A separate feed mechanism is provided for rail heads and side heads. The action of this planer is said to produce very smooth surfaces, so that on work that must afterwards be scraped to a bearing the necessary scraping is reduced to a minimum.

This tool is built several sizes by the American Tool Works Co., Cincinnati, Ohio.

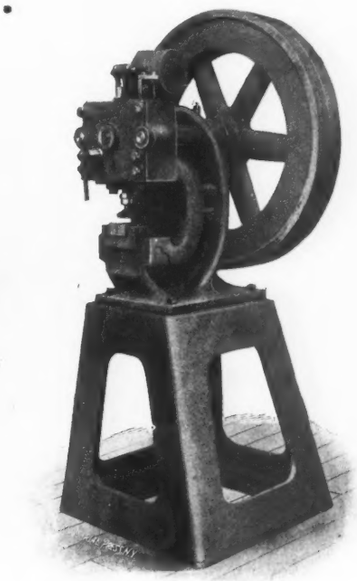
### SMALL POWER PUNCH.

The punching machine shown herewith has been designed by the manufacturers, the Cleveland Punch and Shear Works Co., Cleveland, Ohio, for use in small boiler shops, blacksmith shops, and iron works where a low-priced tool is desired. In this machine the clutch mechanism has been done away with. The flywheel and shaft run continuously and by the use of an automatic gag which operates on the plunger only, this plunger can be stopped at any stroke of the tool at the highest point of its travel. The gag, shown on the front of the cover plate, is quickly and easily operated by the small lever, which throws out automatically, stopping the plunger. In this way the punch can be operated at a high speed without any shock or jar.

The punch holder and die socket are adjustable, and the die block of the machine is so designed that all kinds of structural shapes, bars, plate, etc., may be punched. Shearing tools can be easily substituted for the punching attachment.

The cast iron base on which the machine is mounted may be dispensed with, and the punch mounted on a bench.

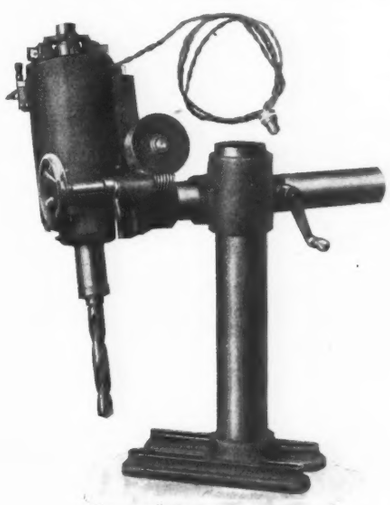
The maximum punching capacity of this machine is $\frac{5}{8}$-inch hole through $\frac{3}{8}$-inch plate, or $\frac{1}{2}$-inch hole through $\frac{1}{2}$-inch plate. Speed about 60 to 70 strokes per minute. The frame is of the solid "Cleveland" type.



Small Power Punch.

### PORTABLE ELECTRICALLY-DRIVEN RADIAL DRILL.

The portable electric drill shown here has a capacity of $1\frac{1}{4}$ inch and is provided with a 10-inch feed through the handwheel, with a quick return by hand. It can be carried anywhere and used for inside and outside work. The driving



Portable Electric Drill.

power is obtained from any ordinary incandescent lamp socket.

This drill has a radius of 24 inches in any direction and at any angle. The spindle is fitted with a ball-bearing thrust and carries a No. 3 taper socket. It has two speeds, by means of a thumb lever on the side, at the lower end of the motor.

It is also provided with a switch, to start and stop it, and the machine is under perfect control of the operator at all times.

The vertical and horizontal columns are made of hollow steel tubing. The base is in the form of a letter H, with suitable slots for clamping bolts. The gross weight of the drill is 210 pounds; height 30 inches over all. It is built by the Hisey-Wolf Machine Co., Cincinnati, Ohio.

## SIXTY-INCH RADIAL WITH SPEED VARIATOR AND CONSTANT SPEED MOTOR.

A speed variator giving positive drive, with arrangement for change of speed, is now manufactured by the Dreses Machine Tool Company, Cincinnati, O., for use in connection with their radial drills. The illustration, Fig. 1, shows the variator attached to a 60-inch radial drill, which is designed to be

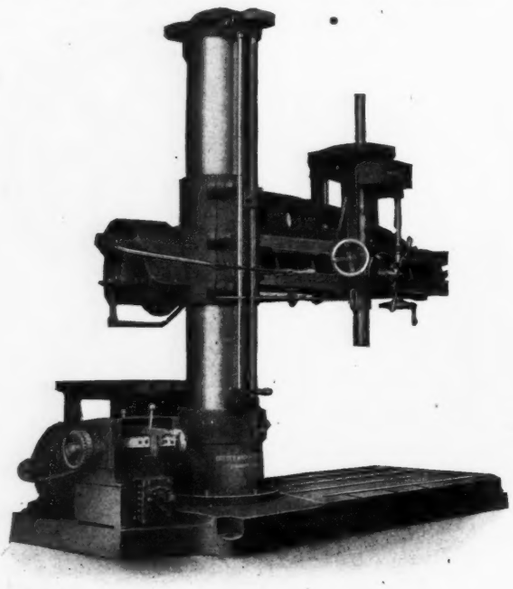


Fig. 1. Dreses Radial Drill with Speed Variator.

operated by a constant-speed motor; and the outline drawing, Fig. 2, makes clear the principle of operation. The drill is made with the outside column swinging on an inside stump fixed to the base and reaching almost to the top. The clamping is done by a split band encircling part of the fixed stump

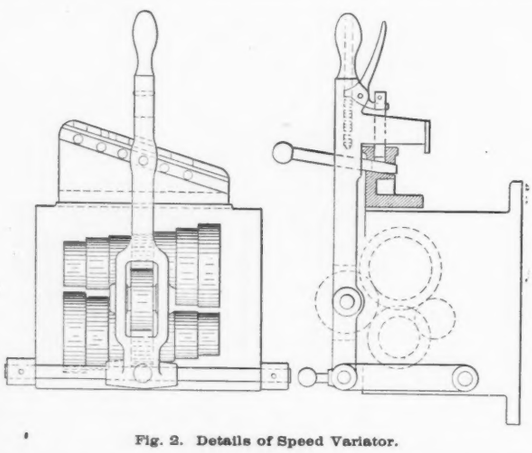
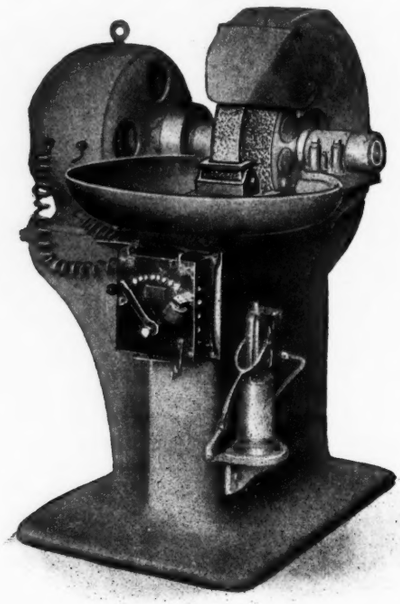


Fig. 2. Details of Speed Variator.

and a flange at the lower end of the column turned to equal diameters. Driving of the drill spindle is done by a horizontal shaft near the base, a pair of miter gears and central shaft in the column, two spur gears on top of column and outside vertical shaft. This shaft carries a pair of miter gears and drives the upper shaft shown in the rear of the arm. Connection between this shaft and the shaft below, transmitting power to the drill spindle, is made by four friction gears operated by the adjustable handle rod shown below the arm and the handle attached to the arm. When the handle rod is in the central position the drill head mechanism stops; pushed to the right the spindle runs fast, without back gears, and pushed to the left, slow, with back gears engaged. By pushing the handle on the arm to the left, the spindle reverses to a fast speed, as the friction wheel making connections to the lower shaft is meshed indirectly by an idler journaled in the frame. By means of an adjusting screw on the operating lever the brake power can be regulated so as to avoid breakage of taps when over-strained or striking an obstruction. The power feed to the drill spindle is of the geared type, has six changes and is variated by shifting the knurled knob on the feed rod that controls a feather by which any desired gear is engaged.

The speed variator has two shafts with seven gears on each, proportioned for seven speeds in geometrical progression, but not in mesh with each other. All these gears are fixed to their shafts, except the largest driven one on the variable speed shaft, which is connected by a pawl and ratchet arrangement. Connection between this ratchet gear and the smallest gear on the driving or constant speed shaft is formed by an idler pinion causing the driven shaft to run always at the slowest speed. When the speed of the variable speed shaft is increased the ratchet fixed on this shaft runs ahead of the pawl in the loose gear. The lever with handle shown in front of the speed variator swings in the rear on a bridle, carries a gear forming connections between the different gears on the



Bridgeport Motor-driven Water Tool Grinder.

two shafts, and is shiftable lengthways. The latch with plunger below the handle locks the handle vertically and the knobbed pin horizontally, all as shown diagrammatically in Fig. 2. The holes for locking in the index plate are drilled to suit the correct positions of the intermediate gear in mesh with the cone gears. No engagement can be made unless the intermediate gear is in the correct position. Though the inertia from rest to the different speeds has not to be overcome, as the variable speed shaft runs always at the slowest speed, the shock from low to high speeds proved to be still too great, and a frictional connection between the drill shaft and variator had to be introduced. This friction is similar to a planer feed friction and is adjusted to carry the heaviest load of the drill, but slips when taxed beyond this.

## MOTOR-DRIVEN WATER TOOL GRINDER.

The Bridgeport Safety Emery Wheel Co., Bridgeport, Conn., have recently applied motor drive to their water tool grinders in what is proving a very satisfactory manner. A bracket is cast onto the side of the base and a Crocker-Wheeler motor is bolted on the bracket and direct-connected to the emery wheel spindle by a coupling which, when unbolted, allows the emery wheel spindle to be taken out easily for putting in a

new wheel. This arrangement makes a positive drive without the use of bolts or chains and the machine is self-contained. Wheels on this class of machines run at a somewhat slower speed than the ordinary emery wheel, and this is arranged for by having a specially-wound armature to meet the requirements of speed for the different sizes of wheels that are used. The machine is equipped with knife switch and starting box with no-voltage release, and also has a speed regulator to increase the speed of the wheel as it wears away, thus giving the same cutting speed when the wheel is half worn out as when it is new. The grinder itself is provided with water reservoir and air pump connections for applying the water to the wheel in the manner that was described and illustrated in the July number of MACHINERY. These grinders are manufactured in four sizes for carrying wheels 20, 26, 36 and 42 inches in diameter.

## SMITH & MILLS SHAPER.

The illustration, Fig. 1, shows a new design of shaper built by Smith & Mills, Cincinnati, O., who have made a specialty of shapers for the past sixteen years. The chief feature of the design is the compact speed-changing device, or mechanism, by which the operator can readily change his speeds without stopping the machine or removing any of the parts.

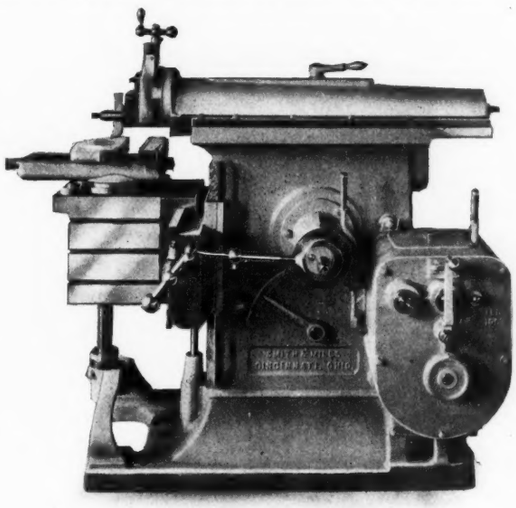


Fig. 1. Smith & Mills Shaper, with Speed Changing Device.

The speed box is very compact, resting on the base and attached securely to the side of the column. It contains all the gears and parts required to perform its work, the main features being a cone of gears, a driving pinion and a revolving carrier having arms to which are attached idle pinions. These couple alternately the driving pinion and one of the gears on the cone shaft. The cone shaft engages the bull wheel which operates the crank and gives motion to the tool head.

In the line drawing, Fig. 2, *A* is the cone of gears; *B* the carrier, on which are the intermediate pinions *C C C*, etc. The carrier is rotated by a pinion *D*, which is operated by a crank, so as to bring any one of the pinions into position between the cone and the main pinion *E*.

The main driving shaft runs through the box and column with a bearing on the rear side; beyond this are the tight and loose driving pulleys. One revolution of the crank in either direction changes the position of the carrier from one arm to another and thus changes the speed.

The lever seen protruding from top of box is to connect the back or compound gears. The lever between the box and the central shaft in column is for starting or stopping the machine. There are 8 specific changes and 64 variations of stroke.

In designing this drive care has been taken to make it convenient and durable and to have it appear as a component part of the machine. The gears are of drop forged steel and the pinions of best quality of gun metal, insuring solidity and lasting qualities. This all-gear arrangement makes the machine powerful, adapting it for use of the high speed cutting steel now in vogue. An advantage of this drive is that no matter at what speed the tool is cutting, there is a uniform tension on the driving belt. It does away with cone pulleys and shifting belts, and lessens the liability of injury to workmen. It also provides an ideal drive for motor connection by using a plain and simple constant-speed motor.

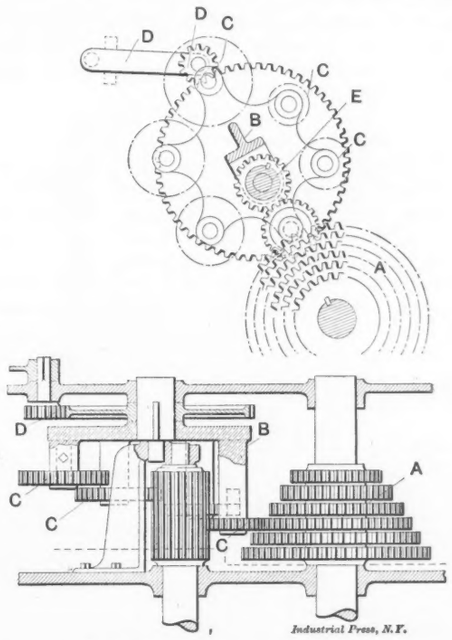


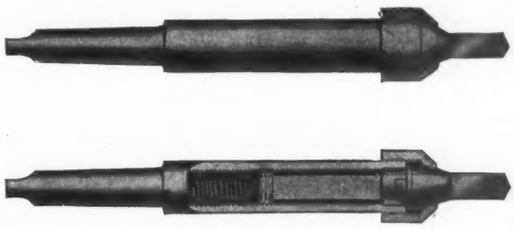

Fig. 2. Sectional View of Mechanism.

The illustration shows the device attached to a 20-inch crank shaper, but the same device is made suitable for various sizes from 12 to 24 inches stroke.

The shaper is provided with wide flat bearings with adjusting gibs and large journal bearings. A patent wristpin used for changing the stroke, allows the stroke to be changed without stopping the machine. Opening under the ram admits shafts of any length for key seating. There are micrometer dials on the vertical feed and cross screws, for cutting racks, key seats and division work. The eccentric feeding plate is drilled to correspond with the ratchet wheel, dividing the space so that an even tooth is fed at all times.

## THE RICH DRILL CHUCK FOR FLAT DRILLS.

The drill chuck shown in the accompanying illustrations is designed for the economical use of high-speed steel for flat drills. No blacksmith work is required, the chuck being so constructed that no forging is necessary as the machinist can shape the drill from the flat bar by grinding. The chuck consists of a long sleeve into one end of which is screwed the shank which is made standard Morse taper so as to fit any drill press, and at the other end of the sleeve is the collet for



Drill Chuck for Flat Drills.

holding the flat drill. The interior of the sleeve is threaded for nearly its entire length and a threaded plug fitting therein is provided having a slot in which fits the shank end of the drill. By engaging the end of the drill in the slot the plug can be turned in or out of the sleeve so as to accommodate the drill to the depth of the hole to be drilled. This is an important feature of the chuck since the length of the drill

need never be more than that necessary for the depth of the holes being drilled and in this way the maximum stiffness of the drill is available for the work in hand. A bushing is fitted in the lower end of the sleeve to center the drill, the bushing being changed to accommodate different size drills. A slot is milled across the lower end of the sleeve in which are fitted lugs on the jaws to prevent the drill turning in the chuck. Over the jaws is fitted the tapered and threaded sleeve for compressing the jaws.

The chuck is made in a variety of sizes for drill presses, and small size chucks are made specially for use on air motor drills by the George R. Rich Mfg. Co., 171 South Canal St., Chicago, Ill.

## PLATE STRAIGHTENING ROLLS.

The accompanying cut illustrates a machine designed for straightening plate for boilers, tanks, safes, structural work and all other purposes. The machine has nine rolls arranged in two tiers—five rolls in upper tier and four in the lower. The upper series of five rolls are adjustable vertically, to suit thickness of sheet to be straightened. The outer rolls of this series are adjustable independently, by means of worm and worm wheel. The three inner rolls are raised and lowered together and arrangement is provided whereby all the upper rolls may be adjusted, after being once set, without change in their relative positions.

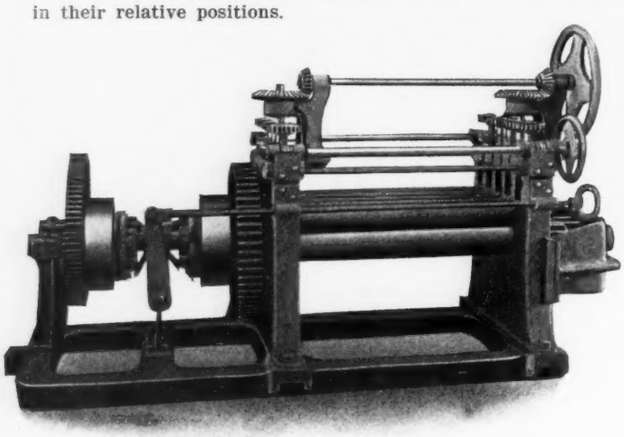


Plate Straightening Rolls.

The lower series of four rolls are all geared together by means of steel pinions. The outer ends of these rolls are supported in a bracket, which also supports the idler pinion. All the rolls are made from steel forgings, amply heavy to prevent spring.

The driving gears are heavy and the ratio of gearing is such that the friction clutch pulleys, with which the machine is provided, are able to do the work easily.

As will be seen in the cut, the rolls are mounted in heavy housings, having wide journal bearings. The machine is self-contained, as all stands and housings are mounted on a heavy bed plate. This obviates the necessity of extensive foundations.

This machine is built by the New Doty Mfg. Co., Janesville, Wis., and the makers claim for this machine that only the best material and workmanship enter into its construction and that it is a most efficient tool and does its work in a perfectly satisfactory manner.

## GRINDER FOR SPECIAL WORK.

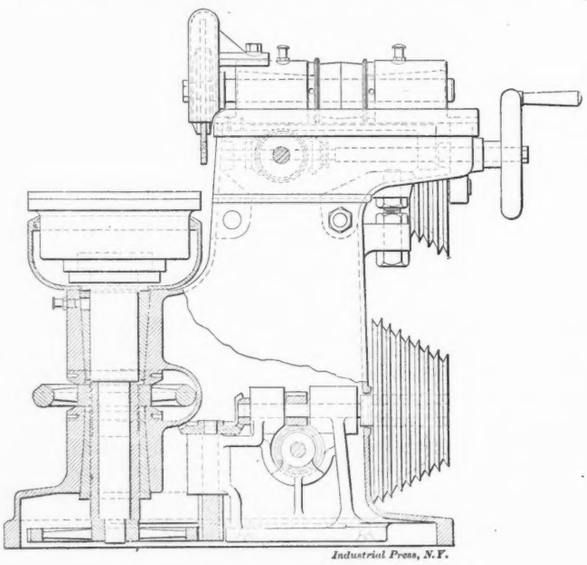
A special grinding machine is now made by the Heald Machine Company, Worcester, Mass., for grinding piston rings, thrust collars, disks, cutters and any thin circular work that is to be ground on its sides. The machine was primarily designed for grinding piston rings, but it has been found well adapted to a great variety of other similar work which is now being done on expensive universal grinding machines and which may be finished as accurately and quickly on a machine of less costly construction.

Inasmuch as piston rings are really double-seated check valves it is important that they fit the grooves nicely, and it is known that a considerable saving in steam or gas consumption can be effected by having the rings so fitted by grinding.

The machine consists of a Walker magnetic chuck 8 inches in diameter mounted on a vertical spindle with micrometer adjustment. The grinding wheel is mounted in a cross slide which can be fed across the work by means of the handwheel shown, or an automatic power cross feed will be added if desired. An adjustment is provided with the upper part of the column so that the machine can be made to grind hollow or crowning at the center of the chuck. This latter feature is of value especially in grinding metal slitting saws which need to be thinner at the center for clearance.

Fig. 1. The Heald Grinding Machine.

The machine is thoroughly built, with adjustable taper bearings as shown in the line drawing, and the wheel for adjusting the vertical feed is graduated to thousandths, and finer if desired. Dust caps are provided for the bearings. The cone pulley which drives the work has eight grooves, enabling the operator to obtain the best speed. The magnetic chuck is particularly convenient for the class of work that is accomplished by the machine, because nothing can be simpler than turning on or off the current, which at once either releases or clamps the work on the faceplate of the machine.



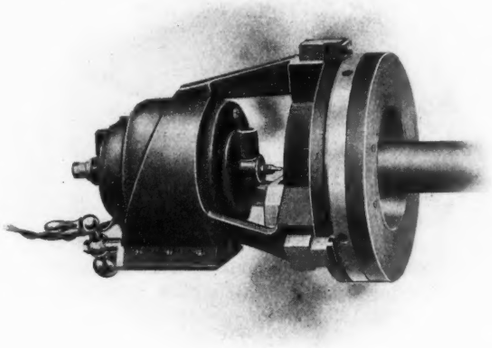
*Industrial Press, N.Y.*

Fig. 2. Sectional View of Grinder.

### PORTABLE CENTERING MACHINE.

A light, portable device for centering shafting, round and hexagon stock, etc., has been brought out, as shown by the accompanying cut. The machine consists of a universal chuck fitted to a frame (in the present instance composed of an aluminum compound) at the opposite end of which is a motor, with a drill and countersink aligned with the center of the chuck. The motor travels in a gibbed slide and is operated by a feed screw and handle, causing the drill and countersink to enter the end of the bar. Wear is taken up by means of slides and set screws, at the base of the casting. A stop across the inside of the chuck opening prevents the drill point from being brought into too sudden contact with the end of the bar, through careless handling.

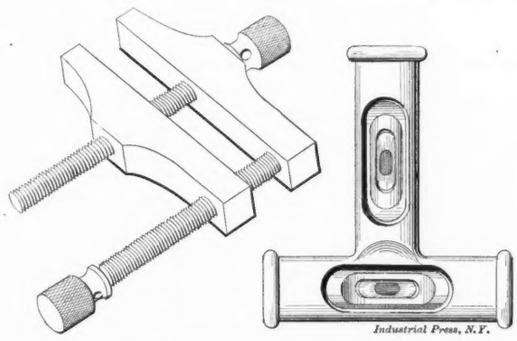
The machine weighs only about 25 pounds. It is 10 inches long and the outside diameter of chuck is 8 inches. Its capacity is for bars up to 4 inches in diameter, which it is not necessary to square up on the ends before centering. Inasmuch as the device is easily carried to the work, and derives its power from any electric light fixture, it obviates the necessity for moving a heavy bar to the centering machine or for centering it in the old-fashioned way in the lathe. It is the invention of Mr. Frank H. Hudson, Room 704, 110 State Street, Boston, Mass., and while it is not yet manufactured regularly for the market, it is intended to make it in different sizes for both large and small work.



Portable Centering Machine.

### A NEW LINE OF MACHINISTS' TOOLS.

The Sawyer Tool Co., Fitchburg, Mass., have brought out a number of new tools, among which are machinists' steel clamps in sizes from 1¼ to 2¾ inches opening, a cross level, an adjustable bench level, a machinists' scriber, etc. The machinists' clamps and the cross level are illustrated herewith. The machinists' clamps, Fig. 1, are of steel, and case-hardened. The screws have a ball and socket bearing upon the jaws, thus eliminating all unnecessary strain from the threads. They are made in three sizes.



Industrial Press, N.Y.

Fig. 1. Fig. 2.

The cross level, Fig. 2, is also neatly enameled, with polished ends, and is particularly useful in quickly leveling up work. It is 2½ by 3 inches by ⅝ inch.

The new scriber, which is not shown here, has a knurled body, to enable the tool to be firmly held. The marking points are of tempered crucible steel, and are held in the body by a taper fit which insures firmness and yet allows them to be removed when necessary. Its length over all is 8 inches.

### CAM FEED DRILL.

An automatic cam feed drill for manufacturing purposes is a late production of the Dwight Slate Machine Co., Hartford, Conn. Fig. 1 shows a 6-spindle drill of this type, and Fig. 2 illustrates the details of the mechanism. The advantage of a cam feed is that the cam may be laid out to give a more rapid feed at the start than toward the end of a hole, so that the drill will be fed more slowly after it has reached a considerable depth, at the point where it is to break through the metal. In Fig. 2, *C* is the cam, which gives the feed motion to the spindle through the connecting rod *R*, the lever *L*, and the familiar pinion and rack connection. Inasmuch as a cam has a certain definite throw it would ordinarily be necessary to provide a new cam for each change in depth to be drilled, unless the drill were allowed to run for a greater or less length of time without doing any work on the metal. To provide against this contingency a slotted lever connection *D* is provided, which lever is driven directly by the cam and consequently has a positive throw. It is slotted its whole length, however, and the pin of attachment for the connecting rod *R* at this lever can be clamped at any point along the length of this slot. By this means the travel of the feed mechanism for a single rotation of the cam may be made a greater or less amount and still the kind of motion given to the drill—that is, rapid at first and slow at the end—will remain the same whatever the depth of the hole. A turnbuckle is provided on the connecting rod *R*, in order that the travel

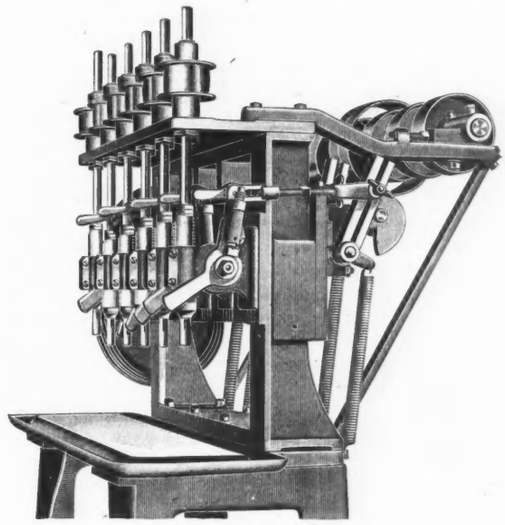
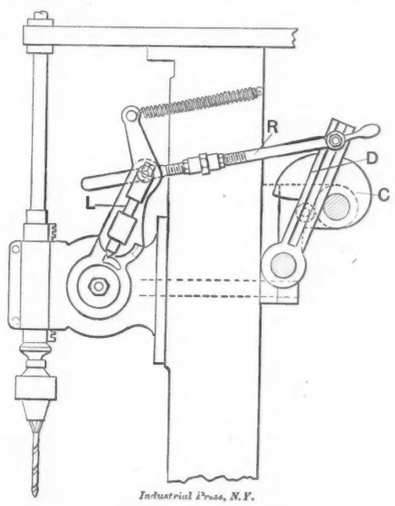


Fig. 1. Cam Feed Drill.




Industrial Press, N.Y.

Fig. 2. Detail of Drill.

of the drill may be correct in relation to the work. A patented safety stop is also provided, by making the lever *L* in two parts. The lower member is locked to the pinion shaft and the upper member, which pivots upon the lower, is held in alignment with the latter by means of a spring pin or latch which locks into a recess on the lower member. If overload occurs the pressure of the cam will break this connection before there is sufficient strain to break the drill.

It will be noted from Fig. 1 that the cams are placed on a shaft at the rear of the machine. These cams are so timed that they operate in succession, and by timing the rotation of the shaft in accordance with work to be done the feed can be adapted to the ability of an operator to tend the machine, and also to the character of the work to be performed.

The connecting rod *R* has a hook connection with the lever *L*, Fig. 2, so that it may be easily disconnected by hand and the spindle moved independently of the feed motion.

### IMPROVED RATCHET GREASE CUP.

The cut herewith shows the improved "Crown" grease cup manufactured by the Winkley Co., Hartford, Conn. It contains a split, threaded packing ring, held in the base of the cup, upon which the cap is screwed. When the cap is screwed on, the slot in the packing ring closes, thereby giving a pressure against the cap which prevents any grease from working out and gathering dust, making the cup unsightly.

The Winkley Oil Cup.

Another feature is that the split ring acts as a check in unscrewing the cap. The ring always tends to expand, and presses outward against the threaded portion of the cup sufficiently to prevent the latter from shaking off when the cup is attached to rapidly running or vibrating machinery. It is also found that the threads of this cup wear much longer than in the ordinary cup having a solid threaded portion.

These cups are manufactured in seven sizes, ranging from ¾ inch to 3 inches inside diameter.

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The D. E. Whiton Machine Company, New London, Conn., have brought out a centering machine of special design for accurately centering shafts 5 inches in diameter, or smaller, which have been previously finished. To accomplish this the work is held in two centering chucks, one of which revolves and acts as a driver.

The shaft is firmly gripped in the revolving chuck, while the end near the tools is supported and revolved in the jaws of the stationary chuck, as in a lathe center rest. The centers may then be drilled and reamed to the required depth by the drilling and reaming tools which revolve in a direction opposite to the work and at different speeds. In this way the tools produce centers which exactly correspond with the surface of the stock. When so centered, such shafts may be turned to receive pistons, pulleys, gears, etc., which may be mounted as accurately as upon fully turned shafts, and a large amount of turning may be dispensed with. The product of the turret lathe may also be conveniently centered and afterward perfectly finished by grinding.

The spindle mechanism, headstock and 3-jaw centering chuck used in this new machine are similar in design, but heavier than those used in their regular two-spindle centering machine, and the machine is of heavier design throughout.

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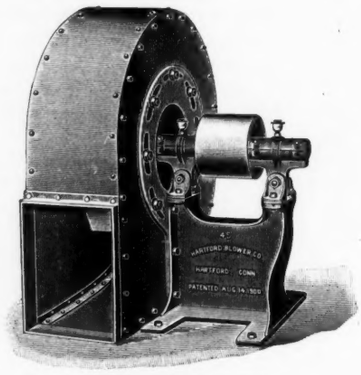
### THE HARTFORD FANS.

The Hartford adjustable exhaust fans are a recent production of the Hartford Blower Company, Hartford, Conn., and possess original and valuable features not contained in non-adjustable fans. The construction is such that over twenty different styles are combined in one machine. As will be clear from the engraving, the casing for the fan is adjustable upon the frame supporting the bearings, and the fan may be placed upright on a floor or suitable foundation, or it may be reversed and bolted direct to overhead timbers, saving the cost of an expensive platform.

All machines are interchangeable. Right-hand machines may be changed to left-hand or *vice versa* at any time, either as upright or suspended machines. The discharge outlet may be adjusted to point in any desired direction at will. Upright or suspended machines may be adjusted equally as conveniently. After using the machine in one position for a time, it may be adjusted for a new position, in order to comply with altered arrangements. While the advantages of these machines are many to the consumer they are particularly appreciated by the dealer, who is able to meet the demands of the trade by carrying a much smaller stock than he would ordinarily carry. Both single and double machines are built, for a large variety of purposes. The housing is of steel plate of such thickness as to withstand the abrading action of the material. A heavy iron pulley standard attached to the housing carries the Hartford patent improved continuous oiling boxes.


Hartford Exhaust Fan.

* * *

One of the features of the new plant of the B. F. Sturtevant Company at Hyde Park, Mass., peculiarly indicative of the permanent character of the new works now under construction, is the steam tunnel 4½ feet in width, and 6½ feet high, extending from the power plant to the most remote part of the manufacturing buildings, a total distance of about 800 feet. This tunnel, which is of concrete construction, will not only accommodate all of the steam piping, but also the electric wires for power, light, telephone, standard time clock, and other service, together with oil, hot water and other pipes for general distribution to the various buildings of the plant. None of these features of the equipment will be carried above ground at any outdoor point. While the expense of such an installation is necessarily large, the convenience of access for changes and repairs will in the future much more than offset any fixed charges thereon.

* * *

## SUMMARY OF NEW TOOLS, CATALOGUES, ETC.
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**MACHINERY describes in each number more new tools and appliances than any other mechanical paper, and a glance over this column will enable the reader to pick out what is of special interest to him.**

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2. It enables the manufacturer to trace the results of his advertising.
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## FRESH FROM THE PRESS.

THE *Patternmaker* for April—the second number of a new journal published by the Iron and Steel Press Co., Cleveland, O., contains 40 reading pages. These are devoted to the following interesting and instructive subjects: "The Pattern Department of the Stilwell-Bierce & Smith-Vaile Co.," illustrated by a large number of half-tones; "Gearing and Gear Patterns," by H. J. McCaslin, a very comprehensive article on this subject; "Pattern Shop Arrangement; Pattern Costs," by R. W. McDowell, and an article on the band saw, showing how the teeth of bevel gear wheels can be sawed out on the band saw and also how a number of other interesting things can be done with it. There are also articles on "A Handy Saw Table," "The Growth of Trees," by Prof. M. J. Golden, with several photographic reproductions of sections of wood; "How to Make a Patternmaker," by Mr. A. J. White, of Akron, O.; "A Cement Chuck," and several other short articles, as well as notes and news of the past month. Sample copies of this interesting journal will be sent upon application.

## NEW TRADE LITERATURE.

**Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes.**

THE BUFFALO FORGE CO., Buffalo, N. Y. Pamphlet illustrating the Buffalo "B" volume blowers and exhausters.

THE HARTFORD BLOWER CO., Hartford, Conn. Catalogue No. 56, treating of steel plate blower and exhaust fans.

THE CINCINNATI PLANER CO., Cincinnati, O. Wall hanger illustrating the Cincinnati planers, and views of the shops of the company.

THE CRANDALL PACKING CO., Palmyra, N. Y. Price list of the "Crandall" packings for steam, ammonia and hot and cold water.

J. L. GARD, Denver, Colo. Leaflet illustrating a handy woodworkers' vise, with a swivel jaw, and opening 15 inches. For further information, address J. L. Gard, 1616 Blake Street, Denver, Colo.

THE CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 35 illustrating and describing the installment of the Crocker-Wheeler system in the new railway shops of the Lake Shore & Michigan Southern Railway, at Collinwood, O.

THE LUCAS MACHINE TOOL CO., Cleveland, O. Descriptive circular of the No. 2 "Precision" boring, drilling and milling machine. A very fine half-tone view of this machine appears, together with a description of its special features.

THE GOODELL-PRATT CO., Greenfield, Mass. Circular calling attention to the hacksaw blades manufactured for use in power machines. The No. 300 heavy hacksaw blade and the No. 500 extra heavy hacksaw blade are shown and prices given.

THE LAIDLAW-DUNN-GORDON CO., Cincinnati, O. Bulletin L-508, an illustrated pamphlet fully explaining the features of the improved Cincinnati air compressor. The pamphlet will be sent upon application to any one interested in air compressing machinery.

FRANK A. SIMONDS, consulting steam engineer, Grand Rapids, Mich. Booklet entitled "Steam Receivers and Separators," which treats of the advantages of the "Simonds" improved steam receiver and separator. This booklet will be sent to anyone interested.

ERNST G. SMITH, Columbia, Pa. Leaflet illustrating the "Columbia" calipers. These instruments have hardened jaws and are warranted accurate and satisfactory. The "Which Way" pocket level is also shown. This leaflet will be sent to any one interested.

THE AMERICAN TURRET LATHE MFG. CO., Warren, Pa. Three circulars illustrating and describing respectively the 6 x 48-inch, the 22-inch and the 24 and 27-inch semi-automatic turret lathes. These lathes are powerfully built and if desired may be fitted for electric driving.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Folder treating of Dixon's graphite pipe joint compound, which comes in 4-ounce collapsible tubes that may be carried in the pocket or tool bag, for use on screw joints of every sort, pipe fittings, flanges and faced connections.

THE KNOWLES STEAM PUMP WORKS, New York. Illustrated catalogue, K-104, specially devoted to pumping machinery for beet sugar factories. The different sizes and styles of the "Knowles" steam pumps are here illustrated and described and some interesting information given regarding the beet sugar industry.

THE NEW JERSEY FOUNDRY & MACHINE CO., New York. Illustrated catalogue of the "Coburn" system of trolley tracking, for use in mills, foundries and machine shops, etc. These tracks are built for light and heavy loads. A number of views show the "Coburn carrying track" in operation in a machine shop, a cotton mill, railway repair shop, etc.

THE ERIE ENGINE WORKS, Erie, Pa. Circular calling attention to the engines and boilers manufactured. These include automatic, stationary, detached, double portable, semi-portable, combined agricultural and return-flue portable engines; and stationary, portable, "Columbia" and vertical boilers.

THE EMERSON ELECTRIC MFG. CO., St. Louis, Mo. Catalogues Nos. 2660 and 2670 of electric motors. The former treats of the Emerson fan motors for alternating current and describes several styles for desk and ceiling use. This is handsomely illustrated. No. 2670 deals exclusively with the Trojan alternating fan motors.

THE W. F. & JOHN BARNES CO., Rockford, Ill. Catalogue No. 61 of drills and machine tools. These are produced in many sizes and styles for light and heavy work. Upright drills are shown, also a 20-inch gang drill, and the No. 1 horizontal radial drill. These tools are belt-driven, but can also be arranged for electric drive, if desired.

THE S. R. SMYTHE CO., Pittsburg, Pa., represented in New York by Dr. Oskar Nagel, 90 Wall St. Catalogue on "suction" gas producers for gas engines, showing the simplicity and advantages of the construction and the economy in fuel attained thereby. These producers are built in units from 5 to 150 horse power and yield 1 horse power hour per pound of coal. No boiler or gas holder is required.

THE CLING-SURFACE MFG. CO., Buffalo, N. Y. Leaflets containing testimonials from prominent firms here and abroad regarding the satisfactory results obtained from the use of Cling-Surface on troublesome belts. One letter, received from the Tokio Electric Light Co., Tokio, Japan, reads in part as follows: "We beg to state that Cling-Surface is giving most satisfactory results for high-speed belting. We have no hesitation in highly recommending it."

THE B. F. STURTEVANT CO., Boston, Mass. Catalogue No. 115, second edition, 1904. This particular catalogue treats in a concise manner of the Sturtevant Co.'s forges, blowers, exhausters, countershafts, blast gates, galvanized iron work, disk and propeller fans, and of engines, dynamos, motors, generating sets, steam heating, ventilating and drying apparatus, etc. Its pages present the essential types of these products, with lists of sizes and important features.

THE STANDARD PRESSED STEEL CO., 20th and Clearfield Streets, Philadelphia, Pa. Illustrated pamphlet, February, 1904, describing the American "Pioneer" pressed steel shaft hanger. This is made entirely of open-hearth steel, pressed to shape. One of the claims for this hanger is maximum strength with minimum weight. Different views of the company's products are given: Drop hanger, floor stand, post hanger; also side and sectional views of the bearings.

THE COOPER HEWITT ELECTRIC CO., 220 West 29th Street, New York. Catalogue descriptive of the Hewitt mercury vapor lamp, a description of which recently appeared in MACHINERY. This can be put to a number of uses: In offices, machine shops, drafting rooms, store houses, factories, etc., and the company claim that the light is soft and not trying to the eyes, owing to the almost entire absence of the red rays, and that the cost is much less than for other systems of lighting.

THE EDGECOMBE CO., Indianapolis, Ind. Circulars and price list of "Red Cross" cement for the cementing of pipe joints. The company claim that not only will this compound make a joint tight, but that it prevents rust, so that the joint can readily be taken apart at any time. It is intended for screwed-joint work and service with water, steam, gas and air, and the company state that it is not affected by heat, acids, alkalis, superheated steam or electricity.

THE C. W. HUNT CO., West New Brighton, N. Y. "Industrial Railway" catalogue, just issued. This book is very complete, contains a large number of illustrations showing the many and varied types of cars, standard and special, built for all purposes of transportation. Also the tracks and switches adapted to the various styles and sizes of cars. An electric locomotive, for hauling loaded cars, also appears. Considerable information on the subject of industrial railways is to be found here.

THE AMERICAN MACHINERY CO., Grand Rapids, Mich. Illustrated catalogue of the Nos. 2, 3, 5 and 6 "Oliver" wood trimmers. These four sizes are shown by half-tone views, and quite a complete description of the principle of the "Oliver" trimmers is given. Also pamphlets describing and illustrating the "Oliver" universal saw bench, the "Oliver" hand planer and jointer and the "Oliver" band saw, type B—a line of new tools in which the company think readers will be interested.

THE AMERICAN BLOWER CO., Detroit, Mich. Catalogue No. 159, devoted exclusively to the subject of brick drying by the use of the "A B C" waste heat drying apparatus. This book contains 77 pages devoted to information regarding this system, and to illustrations of the kilns, steel plate fans and engines used. A table giving the capacities of the various sizes of standard steel plate fans at varying revolutions, and one giving capacities of these fans at varying pressures, and other useful tables also appear.

THE DIAMOND MACHINE CO., Providence, R. I. Illustrated catalogue, 1904, of Gorton disk grinders. Herein are described and shown the universal and plain disk grinding machines manufactured, in many sizes and styles, for working on plain surfaces and for circular work in great variety. Some of these machines are belted and others electrically driven. Some space is devoted to a line of vertical spindle grinders—several half-tones and line cuts showing the construction of this type of machine—and samples of the work turned out on the "Gorton" grinders also appear.

THE G. A. GRAY CO., Cincinnati, O. Illustrated catalogues, recently issued, of planers. These are of two distinct types, the spur-geared planers and the spiral-geared planers. They are built in a variety of sizes, and furnished with any of the following electric drives: On the spur-geared planers, direct-connected drive, silent chain-geared drive and motor-belted drive; on the spiral-geared planers, self-contained drive and the motor-belted drive. The planers are built in any length of bed, with single or double heads on rail, and side heads on either one or both housings.

J. H. WILLIAMS & Co., Brooklyn, New York. Illustrated catalogue, 12th edition, 1904, of drop forgings. This contains a description of all the drop-forged specialties carried in stock, including several which were added to the company's line during the past year. They call attention to their external gage forgings, and to the internal gage forgings which are made to correspond in size and design with the external forgings; also double-head hexagon box wrenches. The catalogue is very tastily gotten up and contains a large number of illustrations. Several pages illustrate special drop forgings which are not carried in stock, but show the character of the work done. These forgings are made of iron, steel, copper, bronze and aluminum.

THE BROWN & SHARPE MFG. CO., Providence, R. I. General catalogue, 1904, of machinery and tools. This catalogue has been thoroughly revised and contains 482 pages. The principal additions for this year are given in a colored insert, in which special attention is also called to their line of milling machines which is very complete and embodies new features of importance and value; also to their new method of indexing (which is now applied to their universal milling machines) to their very full line of machinists' tools, etc. The book contains a large number of useful tables and other valuable information, besides a very complete index. This catalogue is mailed upon application to any address without charge, or is furnished by hardware and supply dealers.

THE B. F. STURTEVANT CO., Boston, Mass., announce that the second edition of their catalogue No. 115 is now ready for distribution. It describes and illustrates a number of new apparatus among which are: A new type of hand-blower; several new types and sizes of forges; new sizes of vertical single and double engines; a new type of enclosed vertical compound engine; new type of semi-enclosed bi-polar and 4 pole motors; new sizes of generating sets with vertical compound engines; factory equipments, such as bench-legs, pattern storage shelf brackets, electric hoists, cast-iron sinks, trench cover-plates, etc.; industrial railway equipments, such as cars, truck ladles, turntables, T-rails, etc. It also contains a description of the various Sturtevant systems, such as heating and ventilating, special ventilating, drying, conveying and mechanical draft systems.

HAMMACHER, SCHLEMMER & Co., New York. Catalogues Nos. 1223, 1224 and 1225. The first of these shows a miscellaneous assortment of tools and supplies used in the shipping rooms of large warehouses, in factories, apartment houses and office buildings, with a brief description of each. No. 1224 treats of saws and saw sets exclusively. Herein are listed hand saws, gage saws, miter-box saws; back saws; dove tail, joiner and plumbers' saws; pruning saws, the "Little Giant" pruning hook and saw, compass saws, keyhole saws, turning saws, coping saws, and a number of saw sets for various purposes. The company also carry a full line of circular saws, saw vises, hacksaw blades and frames, files, swages, etc. Catalogue No. 1225 deals with planes exclusively. This is very complete, illustrating a great variety of planes for all possible purposes. The two catalogues on saws and on planes are new departures in this line, separate catalogues for these tools not being generally issued by tool houses. A discount sheet for each of these catalogues has also been issued.

## MANUFACTURERS' NOTES.

THE DETRICK & HARVEY MACHINE CO., Baltimore, Md., have informed us that their plant was not damaged in the great Baltimore fire.

MR. FRANK H. HUDSON, the inventor of the portable centering machine described in another column of the paper, desires to correspond with concerns or individuals interested in reference to putting the machine on the market. His address is Room 704, 110 State St., Boston, Mass.

THE WARNER & SWASEY CO., Cleveland, O., have secured the services of Mr. David Hunt, Jr., formerly for several years with Manning, Maxwell & Moore, but recently Treasurer of the Baush Machine Tool Co., Springfield, Mass. Mr. Hunt has taken the position of general sales manager for the Warner & Swasey Co.

THE OESTERLEIN MACHINE CO., Cincinnati, O., have sent us a copy of a testimonial letter received by them from the Darling Pump & Mfg. Co., Ltd., which reads, in part, as follows: "Having tried for fifteen years all the various makes of friction clutches, we feel that there is nothing that comes anywhere near the Oesterlein for durability and efficiency."

THE PHOSPHOR-BRONZE SMELTING CO., Ltd., Philadelphia, Pa., have sent us a copy of their revised price-list No. 22 of their "Elephant" brand phosphor-bronze. The company state that their new rolling mill is now in successful operation, and with greatly increased facilities and a well-assorted stock of manufactured goods on hand they are now able to fill orders promptly.

THE AMERICAN MACHINERY CO., Grand Rapids, Mich., inform us that Mr. A. N. Spencer, for 25 years with J. A. Fay & Co., and later with the J. A. Fay & Egan Company, has joined forces with Mr. Oliver in the American Machinery Company. Mr. Spencer has a thorough knowledge of woodworking machinery. The company contemplate enlarging their plant; new machines are to be constructed which will be high grade in every respect.

THE RAND DRILL CO., New York, report that there has been a large increase of sales in their "Imperial" pneumatic tool department since the first of the year. Orders have also been received for their piston air drills, wood boring machines and hammers; and they have installed a number of complete pneumatic tool plants in railroad shops, ship yards, boiler works, foundries and bridge and iron works in this country and abroad.

THE AMERICAN TOOL WORKS CO., Cincinnati, O., inform us that they have purchased manufacturing rights under several patents pertaining to speed-changing devices. These patents, they believe, give them the undisputed right to build, without fear of patent infringement, their improved "American" engine lathe with quick changing mechanism for thread cutting and feeding. The line of sizes in which this lathe is built ranges from 14 to 36 inches swing inclusive.

JOSEPH V. WOODWORTH, 57 Tompkins Avenue, Brooklyn, N. Y., who will be remembered as one of our contributors on the subjects of dies and sheet metal work, has opened an office at the above address, where he is prepared to give advice as a consulting mechanical expert on the treatment of steel, special machinery, dies, molds, jigs and fixtures for interchangeable manufacturing, etc. A copy of his "Booklet A" will be sent to any address on application.

THE BURT MFG. CO., Akron, O., announce among recent orders, the following: The Jones & Laughlin Steel Co., a 30-inch exhaust head for their plant at Pittsburg; the American Shipbuilding Co., Lorain, O., an order for Cross oil filters; a cable order from Paris, France, for a large shipment of Cross oil filters; an order from a large plate-glass factory at Alexandria, Ind., for three 16-inch exhaust heads.

HAMMACHER, SCHLEMMER & Co., New York, have placed on the market a new product in the shape of a setscrew having a hexagon socket in the head for the application of the wrench and which is threaded the full length. This construction makes it possible to turn the screw in flush with the surface, or below it, and it obviates the great danger attending the use of the square head setscrew on revolving shafts, etc. One length of screw is all that is required for any depth of hole. For further information we refer to the advertisement in this issue.

H. W. JOHNS-MANVILLE CO., 100 William Street, New York have just placed on the market a new fireproofing material, "Ceilinite," for fireproofing ceilings in electric cars, for which purpose it is being used by the Pennsylvania Railroad Company and the Interborough Rapid Transit Company. It may be used also for lining partitions, side walls, etc. It is made in pieces ¼ to ⅜ inch thick, 36 inches wide and about 50 feet long. Samples can be obtained from the manufacturers in New York, Milwaukee, Chicago, St. Louis, Boston, Philadelphia, Pittsburg, Cleveland, New Orleans and London.

BARTZ, WYGANT & BROWN, Hornellsville, N. Y., have designed a 10-inch portable electric bench drill for light, rapid drilling up to ¼-inch holes. It has five changes of speed, and the table can be raised or lowered, or swung to either side and locked in any position. The bearings are self-oiling and require little attention. The principal dimensions of this drill, are: Greatest distance from spindle to table, 9 inches; vertical adjustment of table, 6½ inches; table diameter, 8 inches; distance from center of spindle to frame, 5¼ inches. It weighs 100 pounds.

THE H. W. JOHNS-MANVILLE CO., 100 William St., New York, announce that they are placing on the market a material for which they have adopted the trade mark of "Niagrite," for preventing loss by fire and danger to life from the short-circuiting of high-voltage electrical wires. It comes in strips of several widths from 3 to 36 inches and is held in place with asbestos fire-proof glue, thus protecting the cables from external fire and confining the internal fire. The material has been adopted by a number of prominent concerns. Full particulars may be obtained from the Asbestos Department of the Johns-Manville Co.

THE HARTFORD BLOWER CO., Hartford, Conn., announce the following recent orders: "Hartford" exhaust systems for the Oak Duke Lumber Co., Wellsville, N. Y., and for the Pennsylvania Match Co., Bellefonte, Pa., a third order for an exhaust system from the L. S. Starrett Co., Athol, Mass.; an order for twenty-four Hartford patent improved cyclone dust collectors; an order for an exhaust system from the Ivor Johnson Arms & Cycle Works, and one from the American Emery Wheel Works. The Hartford Co. design and give estimates free of charge on exhaust systems of all kinds, as well as heating, ventilating and mechanical draft apparatus, and all letters, inquiries, will receive prompt attention.

THE NORMAN W. HENLEY PUBLISHING CO., 132 Nassau Street, New York, have just issued a 40-page pocket catalogue of their up-to-date scientific and practical books, including and fully describing such works as "Dies, their Construction and Use," by J. V. Woodworth; "Mechanical Movements, Powers, Devices and Appliances," by G. D. Hiscox; "Modern Machine Shop Tools," by Wm. H. Van Der Voort; "The Modern Machinist," by John T. Usher, and many other practical works indispensable to the machinist, mechanic, electrician, etc. This catalogue will be sent free to anyone requesting it, and every progressive machinist or practical man should have it. We advise all our readers to write to-day for a copy of it.

W. H. COVERDALE & Co. have recently been incorporated to do a general engineering and contracting business, with offices at 66 Broadway, New York. Their organization includes engineers of experience in all matters relating to the design and construction of steam and electric railroads, lighting and power plants, coal and ore handling machinery, etc. Mr. Coverdale was for many years in the engineering department of the Pennsylvania lines west of Pittsburg, and was Track Elevation Engineer of that company in Chicago during 1898-99. He was also prominently identified with the construction of the Westinghouse shops at East Pittsburg, and for the last three years has been Civil Engineer for a New York firm of engineers and contractors.

THE AMERICAN WATCH TOOL CO., Waltham, Mass., have re-acquired from the Loop-Lock Machine Co. their former factory plant and all assets appertaining to the manufacture of watch tools, precision and automatic machinery, watchmakers' lathes and attachments. The company request, therefore, that all further communications in regard to above lines shall be addressed to the American Watch Tool Co., which title they have again assumed as a Massachusetts corporation. They take upon themselves the responsibility of liquidating all the indebtedness of the Loop-Lock Co., and desire, therefore, to receive early remittances of all accounts due. The company state that they are better equipped than ever before, with larger facilities for meeting demands.

ROYAL E. BURNHAM, patent attorney, Washington, D. C., has just gotten out a new and enlarged edition of an interesting booklet which contains much information concerning patents, trade-marks and copyrights. The booklet presents in a convenient and readily accessible form such information as will enable persons to proceed intelligently to secure letters-patent on their inventions, register their trade-marks and obtain copyrights. Among the subjects treated are what may be patented, the preliminary examination, cost of securing patents, the application, scope of applications, patentees, examination of applications, appeals, interferences, caveats, designs, opinions on validity and infringement of patents, patent litigation, value of inventions, etc. The booklet may be had for the asking upon application to Royal E. Burnham, 837 Bond Building, Washington, D. C.

### PNEUMATIC TOOL LITIGATION.

A GREAT many statements of different kinds have been made with regard to the pneumatic patent litigation, and in response to an inquiry we have been furnished the following information regarding the status of the Boyer patents as opposed to those of the Philadelphia Pneumatic Tool Co.: On June 24, 1901, Judge McPherson in Philadelphia rendered an opinion in favor of the Philadelphia Pneumatic Tool Co. and held that neither their hammer nor their handle infringed any claims of the Boyer patent. Judge Adams, of St. Louis, on December 20, 1902, declared the same handle claims of the Boyer patent invalid. The Chicago Pneumatic Tool Co. took an appeal in Philadelphia solely as to the handle, and on December 21, 1903, the Circuit Court of Appeals in Philadelphia reversed the Circuit Court merely as to certain handle claims. On January 13, 1904, the Circuit Court of Appeals in St. Louis, without a consideration of the merits, affirmed the opinion of Judge Adams, finding the handle claims Nos. 42 to 48 of the Boyer patent invalid. From the foregoing it will be seen that some of the handles in the Boyer patent have been found to be valid in Philadelphia and invalid in St. Louis.

Petition for rehearing has been filed in Philadelphia and steps will be taken to have the matter reviewed in the Supreme Court at Washington. There has been no injunction against any of the hammers of the Philadelphia Pneumatic Tool Co. of any nature whatsoever, any assertions to the contrary notwithstanding. The Chicago Pneumatic Tool Co., who were originally aggressors in this litigation, are likely to have their own tools enjoined, since five suits are pending against them as defendants, and it is believed that the hammer and hammer patents owned by the Philadelphia Pneumatic Tool Co. are being infringed by the Chicago concern.

IN regard to the pneumatic tool litigation the Thomas H. Dallett Co., Philadelphia, Pa., assure their patrons that the recent decisions of the courts on pneumatic tool patents do not apply in any way to the Dallett tools. These tools are made under their own patents and buyers assume no risk of infringement or litigation in their purchase.